

PHILOSOPHICAL
TRANSACTIONS:

Giving some

A C C O U N T

O F T H E

Present Undertakings, Studies and Labours

O F T H E

I N G E N I O U S,

In many

Considerable Parts of the World.

VOL. XVI. *For the Years 1686, and 1687.*

L O N D O N,

Printed by *Joseph Streater*, and are to be sold by *Sam. Smith*,
at the *Princes Arms*, in *St. Pauls Church-Yard*. 1688.



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OF THE

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Vol. XVI. For the Years 1886, and 1887.

LONDON,

Printed by J. G. Smith, and are to be sold by J. G. Smith,
at the Printer's Office, in St. Paul's Church-Yard. 1888.

TO THE
RIGHT HONOURABLE
JOHN
EARL OF CARBERY
PRESIDENT

OF THE
ROYAL SOCIETY, &c.

This Sixteenth VOLUME

OF THE
PHILOSOPHICAL TRANSACTIONS

Is Most Humbly Dedicated

By EDMOND HALLEY.



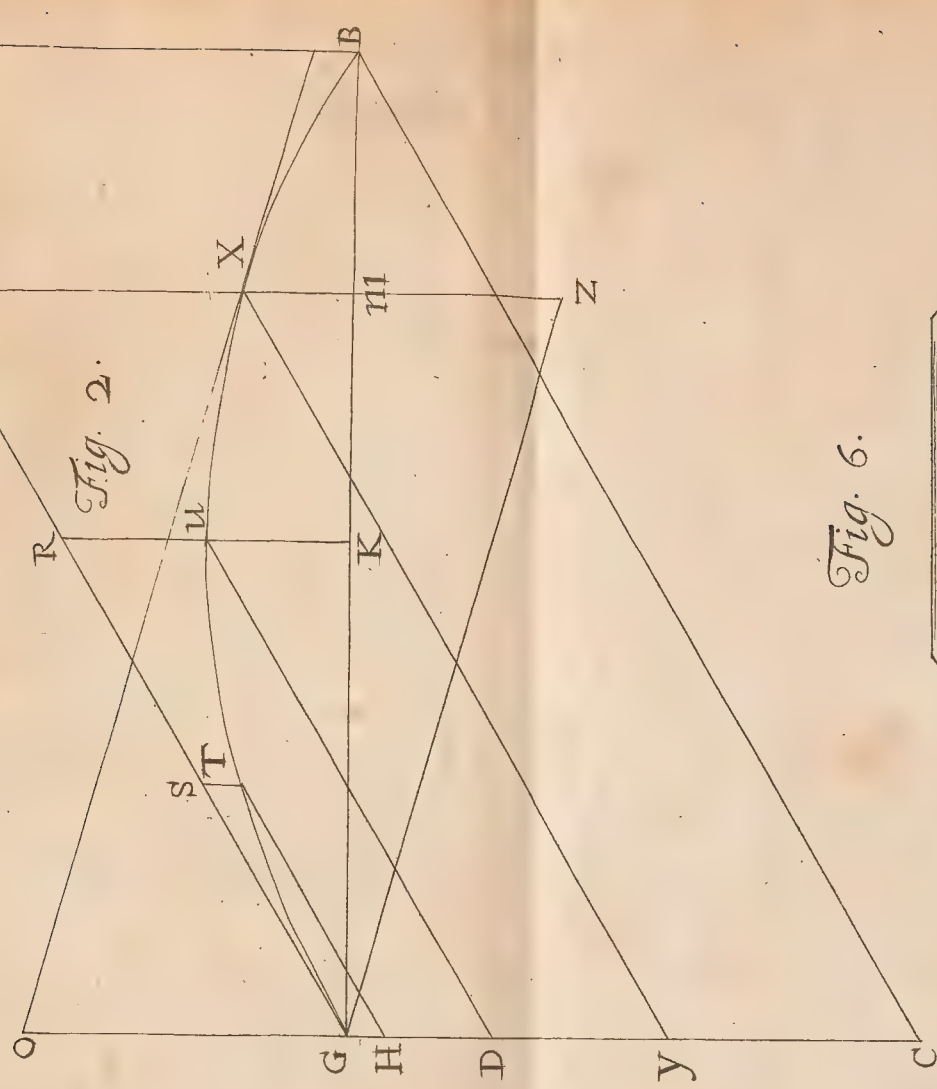
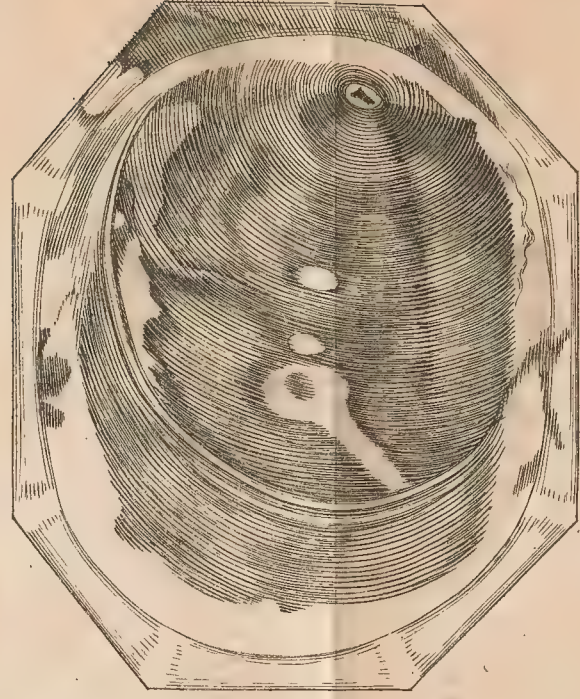
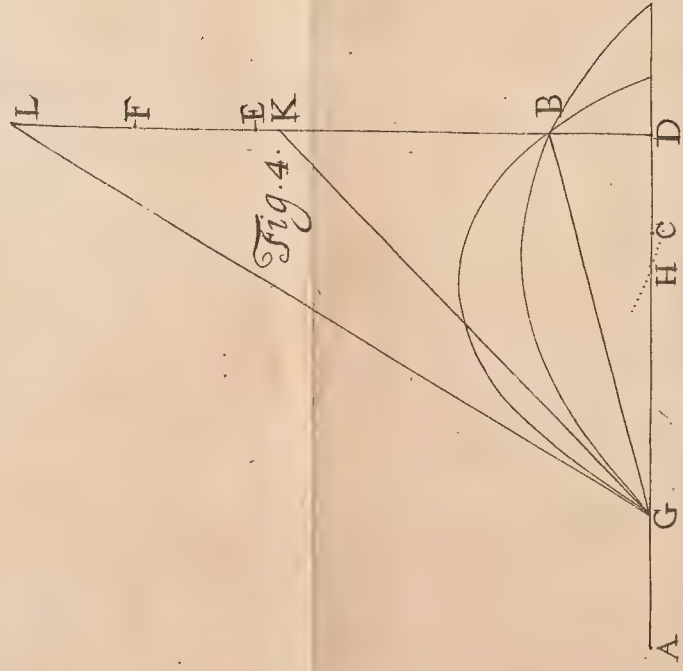
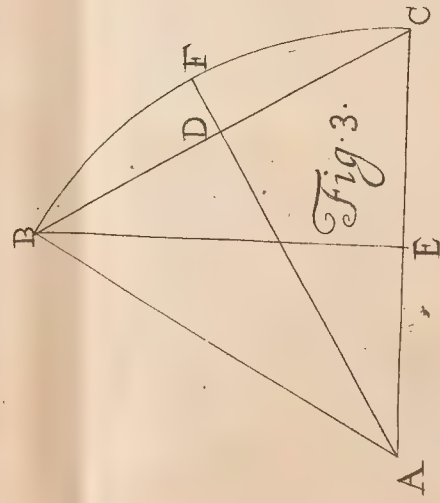
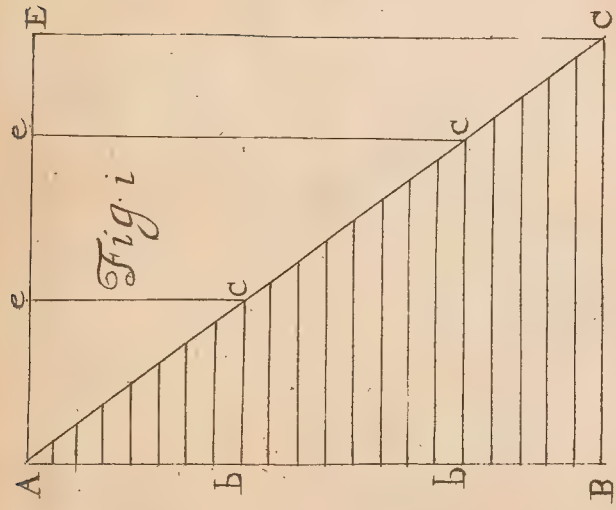
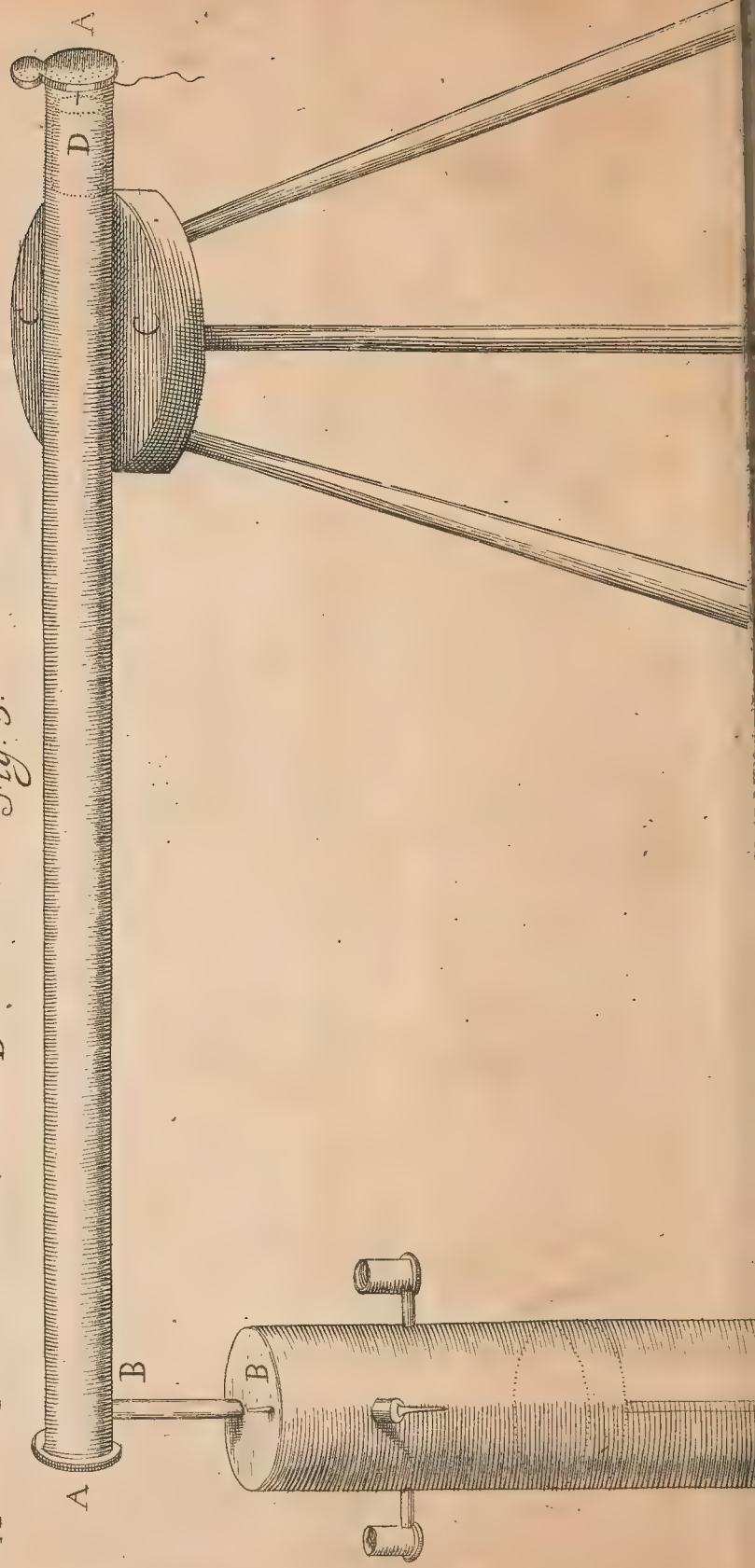
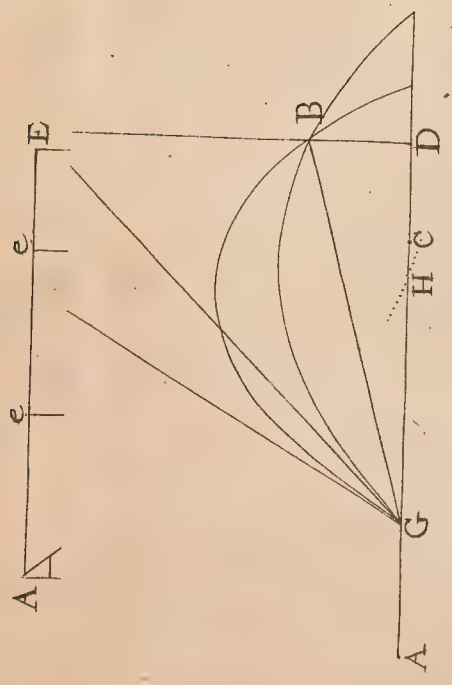


Fig. 5.



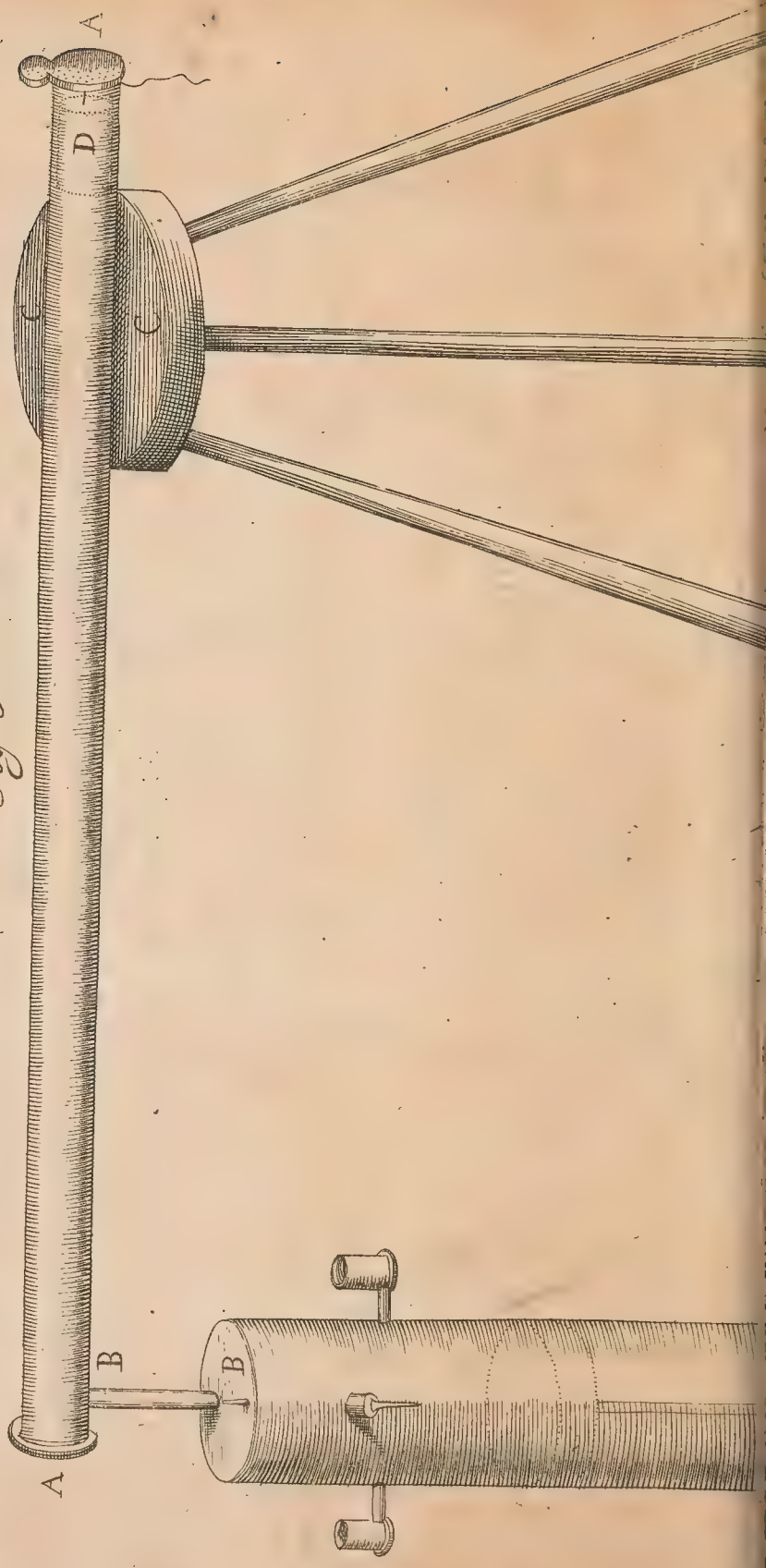
Tab. 1.



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Fig. 5.



PHILOSOPHICAL

TRANSACTIONS.

For the Months of *January*, and *February*, 1686.

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ADVERTISEMENT.

IT having been found by Experience that several Curious Persons have been and are desirous to receive some Account of what the Learned part of the World are for the present busied a-

(a)

lost

about, in the examination of experimental and real Knowledge, and what Discoveries they have made in any part thereof. The Royal Society have therefore thought fit to order, that Care be taken for the future, that such Accounts shall be published in these Transactions Monthly, as may answer their expectations: Wherein will be contained not only several Experiments, Invented and tryed by divers of their own Body, but also such other useful Discourses or Relations concerning Physical, Mathematical, and Mechanical Theories or Observations as shall be communicated by their Correspondants for that Intent, or shall otherwise be sent to, or collected by the Person that hath engaged himself in this Undertaking. He doth therefore hereby Advertise all such Curious Persons as shall be desirous to promote this Design, by Contributing what shall occur to them that may be useful thereunto; that upon their Communications they shall have such Acknowledgments made them as shall be to their satisfaction.

And whereas divers Books and Treatises of such Philosophical Matters as fall under the Societies Consideration, are published in Foreign Parts, which are seldom to be found till some years after, if at all, to the great damage both of the Authors and the Printers of them, and more especially to the Inquisitive of this Nation: It is therefore desired and hoped that for the future, all such Authors or Publishers, or such Ingenious Gentlemen as shall in their Travels meet with such Books or Tracts, will be pleased to send or lend them to the Undertaker of this Affair, that so an Impartial Account and Extract of them may be communicated to the Curious.

And tho' upon an extraordinary occasion these Transactions have for some Months last past been omitted, yet that defect will be soon supplied by the speedy Publication of what has occurred since December last, and will be for the future continued at least as punctually as heretofore.

Those that desire to Contribute to the carrying on of this Work, may please to send the Accounts they would have Printed to Mr. H. Hunt at Gresham Colledge, London, for the Secretaries of the Royal Society.

A

DISCOURSE

*Concerning GRAVITY, and its Properties,
wherein the Descent of Heavy Bodies, and the Motion
of Projects is briefly, but fully handled : Together with
the Solution of a Problem of great Use in GUN-
NERY. By E. HALLEY.*

NATURE amidst the great variety of *Problems* wherein She exercises the Wits of Philosophical men, scarce affords any one wherein the Effect is more visible, and the Cause more concealed than in those of the *Phænomena* of Gravity. Before we can go alone, we must learn to defend our selves from the violence of its Impulse, by not trusting the *Center of Gravity* of our Bodies beyond our reach ; and yet the Acutest Philosophers, and the subtlest Enquirers into the Original of this Motion, have been so far from satisfying their Readers, that they themselves seem little to have understood the Consequences of their own *Hypotheses*.

Des Cartes his Notion, I must needs confess to be to me Incomprehensible, while he will have the Particles of his *Celestial matter*, by being reflected on the Surface of the *Earth*, and so ascending therefrom, to drive down into their places those *Terrestrial Bodies* they find above them : This is as near as I can gather the scope of the 20, 21, 22, and 23 *Sections* of the last Book of his *Principia Philosophiæ* ; yet neither he, nor any of his Followers can shew how a Body suspended *in libero athere*, shall be carried downwards by a

continual Impulse tending upwards, and acting upon all its parts equally : And besides the obscurity wherewith he expresses himself particularly, *Sect.* 23. does sufficiently argue according to his own Rules, the confused *Idea* he had of the thing he wrote.

Others, and among them Dr. *Vossius* asserts the Cause of the *Descent* of heavy Bodies to be the *Diurnal rotation* of the *Earth* upon its *Axis*, without considering, that according to the Doctrine of Motion fortified with Demonstration, all Bodies moved *in Circulo*, would recede from the Center of their Motion ; whereby the contrary to *Gravity* would follow, and all loose Bodies would be cast into the Air in a *Tangent* to the *Parallel* of *Latitude*, without the intervention of some other Principle to keep them fast, such as is that of *Gravity*. Besides the effect of this Principle is throughout the whole Surface of the Glob found nearly equal, and certain Experiment seems to argue it rather less near the *Equinoctial*, than towards the *Poles*, which could not be by any means, if the *Diurnal rotation* of the *Earth* upon its *Axis* were the cause of *Gravity*, for where the Motion was swiftest, the Effect would be most considerable.

Others assign the *Pressure* of the *Atmosphere*, to be the Cause of this Tendency towards the Center of the *Earth* ; but unhappily they have mistaken the Cause for the Effect, it being from undoubted Principles plain, that the *Atmosphere* has no other *Pressure* but what it derives from its *Gravity*, and that the Weight of the upper parts of the *Air*, pressing on the lower parts thereof, do so far bend the Springs of that *Elastick* Body, as to give it a force equal to the Weight that Compressed it, having of it self no force at all : And supposing it had, it will be very hard to explain the *Modus*, how that *Pressure* should occasion the *Descent* of a Body circumscribed by it, and pressed equally above and below, without some other force to draw, or thrust it downwards. But to demonstrate the contrary of this Opinion, an Experiment was long since shewn before the *Royal Society*, whereby it appeared

peared that the *Atmosphere* was so far from being the Cause of *Gravity*, that the Effects thereof were much more Vigorous where the *pressure* of the *Atmosphere* was taken off; for a long *Glass-Receiver* having a light Down-feather included, being *evacuated* of *Air*, the Feather which in the *Air* would hardly sink, did *in vacuo* descend with nearly the same *Velocity* as if it had been a Stone.

Some think to Illustrate this *Descent* of *Heavy Bodies*, by comparing it with the Vertue of the *Loadstone*; but setting aside the difference there is in the manner of their *Attractions*, the *Loadstone* drawing only *in* and *about* its Poles, and the *Earth* near equally in all parts of its *Surface*, this Comparison avails no more than to explain *ignotum per aequum ignotum*.

Others assign a certain *Sympathetical attraction* between the *Earth* and its *Parts*, whereby they have, as it were, a desire to be united, to be the Cause we enquire after: But this is so far from explaining the *Modus*, that it is little more, than to tell us in other terms, that *heavy bodies descend*, because they *descend*.

This I say, not that I can pretend to substitute any *Solution* of this Important *Philosophical Problem*, that shall more happily explicate the *Appearances* of *Gravity*, only it may be serviceable to those with whom the Credit of great *Authors* sways much, and who too-readily assent *in verba magistri*, to let them see that their Books are not always infallible: Besides the detection of Errors is the first and surest step towards the discovery of Truth.

Tho' the Efficient Cause of *Gravity* be so obscure, yet the final Cause thereof is clear enough; for it is by this single *Principle* that the *Earth* and all the *Celestial Bodies* are kept from *dissolution*: the least of their *Particles* not being suffered to recede far from their *Surfaces*, without being immediately brought down again by vertue of this *Natural tendency*, which for their Preservation, the Infinite Wisdom of their *Creator* has Ordained to be towards each of their *Centers*;

nor can the *Globes* of the *Sun* and *Planets* otherwise be destroyed, but by taking from them this power of keeping their parts united.

The Affections or Properties of *Gravity*, and its manner of acting upon *Bodies falling*, have been in a great measure discovered, and most of them made out by *Mathematical demonstration* in this our *Century*, by the accurate diligence of *Galileus*, *Torricellius*, *Hugenius*, and others, and now lately by our worthy Country-man Mr. *Isaac Newton*, (who has an incomparable *Treatise* of *Motion* almost ready for the *Press*.) which Properties it may be very material here to enumerate, that they may serve for a Foundation to all those that shall be willing to spend their Thoughts in search of the true Cause of this *descent* of *Bodies*.

The first Property is, That by this principle of *Gravitation*, all Bodies do descend towards a Point, which either is, or else is very near to the Center of *Magnitude* of the *Earth* and *Sea*, about which the *Sea* forms it self exactly into a *Spherical surface*, and the *Prominences* of the *Land*, considering the Bulk of the whole, differ but insensibly therefrom.

Secondly, That this Point or Center of *Gravitation*, is fixt within the *Earth*, or at least has been so, ever since we have any *Authentick History*: For a Consequence of its Change, tho' never so little, would be the over-flowing of the low Lands on that side of the *Globe* towards which it approached, and the leaving new Islands bare on the opposite side, from which it receded; but for this Two thousand years it appears, that the low Islands of the *Mediterranean Sea* (near to which the ancientest Writers lived) have continued much at the same height above the Water, as they now are found; and no *Inundations* or *Recesses* of the *Sea* arguing any such Change, are Recorded in History; excepting the *Universal Deluge*, which can no better way be accounted for, than by supposing this Center of *Gravitation* removed for a time, towards the middle of the then inhabited parts of the World;
and

and a change of its place, but the two thousandth part of the *Radius* of this *Globe*, were sufficient to bury the Tops of the highest Hills under water.

Thirdly, That in all parts of the *Surface* of the *Earth*, or rather in all Points equidistant from its *Center*, the force of *Gravity* is nearly equal; so that the length of the *Pendulum* vibrating *seconds of time*, is found in all parts of the World to be very near the same. 'Tis true at *S. Helena* in the *Latitude* of 16 Degrees *South*, I found that the *Pendulum* of my Clock which vibrated *seconds*, needed to be made shorter than it had been in *England* by a very sensible space, (but which at that time I neglected to observe accurately) before it would keep time; and since the like Observations has been made by the *French Observers* near the *Equinoctial*: Yet I dare not affirm that in mine it proceeded from any other Cause, than the great height of my place of Observation above the *Surface* of the *Sea*, whereby the *Gravity* being diminished, the length of the *Pendulum* vibrating *seconds*, is proportionably shortned.

Fourthly, That *Gravity* does equally affect all *Bodies*, without regard either to their *matter*, *bulk*, or *figure*; so that the Impediment of the *Medium* being removed, the most compact and most loose, the greatest and smallest *Bodies* would descend the same *spaces* in equal times; the truth whereof will appear from the *Experiment* I before cited. In these two last particulars, is shewn the great difference between *Gravity* and *Magnetism*, the one affecting only *Iron*, and that towards its *Poles*, the other all *Bodies* alike in every part. As a *Corollary*; from hence it will follow, that there is no such thing as *positive levity*, those things that appear light, being only comparatively so; and whereas several things rise and swim in *fluids*, 'tis because bulk for bulk, they are not so heavy as those *fluids*; nor is there any reason why *Cork*, for instance, should be said to be light because it swims on *Water*, any more than *Iron* because it swims on *Mercury*.

Fifthly, That this power encreases as you descend, and de-

decreases as you ascend from the Center, and that in the proportion of the *Squares* of the *distances* therefrom *reciprocally*, so as at a double distance to have but a quarter of the force ; this property is the principle on which Mr. *Newton* has made out all the *Phænomena* of the *Celestial Motions*, so easily and naturally that its truth is past dispute. Besides that, it is highly rational, that the *attractive* or *gravitating* power should exert it self more vigirously in a small Sphere, and weaker in a greater, in proportion as it is contracted or expanded, and if so, seeing that the *surfaces* of *Spheres* are as the *Squares* of their *Radii*, this power at several distances will be as the *Squares* of those *distances Reciprocally*, and then its whole action upon each *Spherical Surface*, be it great or small will be alwaies equal. And this is evidently the rule of *Gravitation* towards the *Centers* of the *Sun*, *Jupiter*, *Saturn* and the *Earth*, and thence is reasonably inferred, to be the general principle observed by *Nature*, in all the rest of the *Celestial Bodies*.

These are the principal affections of *Gravity*, from which the rules of the *fall* of *Bodies*, and the *motion* of *Projects* are *Mathamatically* deducible. Mr. *Isaac Newton* has shewed how to define the spaces of the *descent* of a *Body*, let fall from any given highth, down to the *Center*. Supposing the *Gravitation* to increase, as in the fifth Property ; but considering the smalness of hight, to which any *Project* can be made ascend, and over how little an *Arch* of the *Globe* it can be cast by any of our *Engines*, we may well enough suppose the *Gravity* equal throughout, and the descents of *Projects* in parrallel lines, which in truth are towards the *Center*, the difference being so small as by no means to be discovered in *Practice*. The *Opposition* of the *Air*, 'tis true, is considerable against all light bodies moving through it, as likewise against small ones (of which more hereafter) but in great and ponderous Shot, this Impediment is found by *Experience* but very small, and may safely be neglected.

*Propositions concerning the Descent of heavy Bodies,
and the Motion of Projects.*

Prop. I. The *Velocities* of falling Bodies, are proportionate to the times from the beginning of their falls.

This follows, for that the action of *Gravity* being continual, in every space of time, the falling Body receives a new impulse, equal to what it had before, in the same space of time, received from the same power: For instance, in the first second of time, the falling Body has acquired a *Velocity*, which in that time would carry it to a certain distance, suppose 32 foot, and were there no new force, would descend at that rate with an *equable Motion*; but in the next second of time, the same power of *Gravity* continually acting thereon, superadds a new *Velocity* equal to the former; so that at the end of two seconds, the *Velocity* is double to what it was at the end of the first, and after the same manner may it be proved to be triple, at the end of the third second, and so on. Wherefore the *Velocities* of falling Bodies, are proportionate to the times of their falls, *Q. E. D.*

Prop. II. The *Spaces* described by the fall of a Body, are as the *Squares* of the times, from the beginning of the Fall.

Demonstration. Let A B (*Fig. I. Tab. I.*) represent the time of the fall of a Body, B C perpendicular to A B the *Velocity* acquired at the end of the fall, and draw the line A C, then divide the line A B representing the time into as many equal parts as you please, as b, b, b, b, &c. and through these points draw the lines bc, bc, bc, bc, &c. parallel to B C, 'tis manifest that the several lines, bc, represent the several *Velocities* of the falling Body, in such parts of the time as A b is of A B, by the former proposition. It is evident likewise that the Area A B C is the sum of all the lines bc being taken, according to the method of *Indivisibles*, infinitely many; so that
the

the *Area* ABC represents the sum of all the *Velocities*, between none and BC supposed infinitely many; which sum is the space descended in the time represented by AB. And by the same reason the *Areas* A b c, will represent the spaces descended in the times A b; so then the spaces descended in the times AB, Ab, are as the *Areas* of the *Triangles* ABC, A b c, which by the 20th of the 6 of *Euclid* are as the *Squares* of their *Homologous sides* AB, Ab, that is to say, of the *Times*: wherefore the descents of *falling Bodies*, are as the *Squares* of the times of their fall, Q. E. D.

Prop. III. The *Velocity* which a *falling Body* acquires in any space of time, is double to that, wherewith it would have moved the space, descended by an equable motion, in the same time.

Demonstration, Draw the line EC parallel to AB and AE parallel to BC in the same fig. 1. and compleat the *Parallelogram* ABCE, it is evident that the *Area* thereof may represent the space, a *Body* moved equably with the *Velocity* BC, would describe in the time AB, and the *Triangle* ABC represents the space described by the fall of a *Body*, in the same time AB, by the second proposition. Now the *Triangle* ABC is half of the *Parallelogram* ABCE, and consequently the space described by the fall, is half what would have been described by an *equable Motion* with the *Velocity* BC, in the same time; wherefore the *Velocity* BC at the end of the fall, is double to that *Velocity*, which in the time AB, would have described the space fallen, represented by the *Triangle* ABC, with an *equable Motion*, Q. E. D.

Prop. IV. All *Bodies* on or near the surface of the *Earth*, in their fall, descend so, as at the end of the first second of time, they have described 16 feet one inch *London Measure*, and acquire d the *Velocity* of 32 feet two inches in a second.

This is made out from the 25th proposition of the second part of that Excellent Treatise of Mr. *Hugenius de Horologio Oscillatorio*; wherein he demonstrates the time of the least *Vibrations* of a *Pendulum*, to be to the time of the fall of a *Body*, from

from the height of half the length of the *Pendulum*, as the *Circumference* of a *Circle* to its *Diameter*; whence as a *Corollary* it follows, that as the *Square* of the *Diameter* to the *Square* of the *Circumference*, so half the length of the *Pendulum* vibrating *seconds*, to the *space* described by the *fall* of a *body* in a *second* of *time*: and the length of the *Pendulum* vibrating *seconds*, being found 39,125,01 $\frac{1}{2}$ Inches, the *descent* in a *second* will be found by the aforesaid *Analogy* 16 Foot and one Inch, and by the third *Proposition*, the *Velocity* will be double thereto; and near to this it hath been found by several *Experiments*, which by reason of the *swiftness* of the *fall*, cannot so exactly determine its *quantity*. The *Demonstration* of *Hugenius* being the *Conclusion* of a long train of *Consequences*. I shall for brevity sake omit; and refer you to his *Book*, where these things are more amply treated of.

From these four *Propositions*, all *Questions* concerning the *Perpendicular fall* of *bodies*, are easily *solved*, and either *Time*, *Height*, or *Velocity* being assigned, one may readily find the other two. From them likewise is the *Doctrine* of *Projects* deducible, assuming the two following *Axioms*; viz. That a *body* set a moving, will move on continually in a right line with an *equable motion*, unless some other force or impediment intervene, whereby it is accelerated, or retarded, or deflected.

Secondly, That a *Body* being agitated by two *motions* at a time, does by their *compounded forces* pass through the same *points*, as it would do, were the two *motions* divided and acted *successively*. As for instance, Suppose a *body* moved in the Line GF, (*Fig. 2. Tab. 1.*) from G to R, and there stopping, by another *impulse* suppose it moved in a *space* of *time* equal to the former, from R towards K, to V. I say, the *body* shall pass through the point V, tho' these two *several forces*, acted both in the *same time*.

Prop. V. The *Motion* of all *Projects* is in the *Curve* of a *Parabola*: Let the line GRF (*in fig. 2.*) be the line in which the *Project* is directed, and in which by the first *Axiom* it would

B

move

move equal *spaces* in equal *times*, were it not deflected downwards by the force of Gravity. Let GB be the *Horizontal line*, and GC a *Perpendicular* thereto. Then the line GRF being divided into equal parts, answering to equal *spaces* of *time*, let the *descents* of the *Project* be laid down in lines parallel to GC , proportioned as the *squares* of the lines GS , GR , GL , GF , or as the *squares* of the *times*, from S to T , from R to V , from L to X , and from F to B , and draw the lines TH , VD , XY , BC parallel to GF ; I say the Points T, V, X, B , are Points in the *Curve* described by the *Project*, and that that *Curve* is a *Parabola*. By the second *Axiom* they are Points in the *Curve*; and the parts of the *descent* $GH, GD, GY, GC, =$ to ST, RV, LX, FB , being as the *squares* of the *times* (by the second *Prop.*) that is, as the *squares* of the *Ordinates*, HT, DU, YX, BC , equal to GS, GR, GL, GF , the *spaces* measured in those *times*; and there being no other *Curve* but the *Parabola*, whose parts of the *Diameter* are as the *squares* of the *Ordinates*, it follows that the *Curve* described by a *Project*, can be no other than a *Parabola*: And saying, as RU the *descent* in any *time*, to GR or UD the *direct motion* in the same *time*, so is UD , to a *third* proportional; that *third* will be the line called by all Writers of *Conicks*, the *Parameter* of the *Parabola* to the *Diameter* GC , which is alwaies the same in *Projects* cast with the same *Velocity*: And the *Velocity* being defined by the number of feet moved in a *second* of *time*, the *Parameter* will be found by dividing the *square* of the *Velocity*, by 16 feet 1 inch, the *fall* of a *body* in the same *time*.

Lemma.

The *Sine* of the double of any *Arch*, is equal to twice the *Sine* of that *Arch* into its *Co-sine*, divided by *Radius*; and the *Versed sine* of the double of any *Arch* is equal to the *square* of the *Sine* thereof divided by *Radius*.

Let the *Arch* BC (in *fig. 3.*) be double the *Arch* BF , and A the *Center*; draw the *Radii* AB, AF, AC , and the *Chord* BDC ,

BDC, and let fall BE perpendicular to AC, and the *Angle* EBC, will be equal to the *Angle* ABD, and the *Triangle* BCE, will be like to the *Triangle* BDA; wherefore it will be as AB to AD, so BC or twice BD; to BE, that is as *Radius* to *Co-sine*, so twice *Sine*, to *Sine* of the double *Arch*. And as AB to BD, so twice BD or BC, to EC, that is as *Radius* to *Sine*, so twice that *Sine* to the *Versed-sine* of the double *Arch*; which two *Analogies* resolved into *Equations*, are the *Propositions* contained in the *Lemma* to be proved.

Prop. VI. The *Horizontal* distances of *Projections* made with the same *Velocity*, at several *Elevations* of the *Line* of direction, are as the *Sines* of the doubled *Angles* of *Elevation*.

Let GB (fig. 2.) the *Horizontal* distance be = z , the *sine* of the *Angle* of *Elevation*, FGB, be = s , its *Co-sine* = c , *Radius* = r , and the *Parameter* = p . It will be as c to s ; so z to $\frac{s z}{c}$ = FB = GC, and by reason of the *Parabola* $\frac{p s z}{c}$ = to the *square* of CB, or GF, . Now as c to r , so is z to $\frac{z r}{c}$ = GF, and its *square* $\frac{z z r r}{c c}$ will be therefore = to $\frac{p s z}{c}$: which *Equation* re-

duced, will be $\frac{p s c}{r r} = z$. But by the former *Lemma* $\frac{2 s c}{r}$ is equal to the *Sine* of the double *Angle*, whereof s is the *Sine*: wherefore 'twil be as *Radius* to *Sine* of double the *Angle* FGB, so is half the *Parameter*, to the *Horizontal* rang or distance fought; and at the several *Elevations*, the *ranges* are as the *sines* of the double *Angles* of *Elevation* Q.E.D.

Corollary.

Hence it follows, that half the *Parameter* is the greatest *Randon*, and that that happens at the *Elevation* of 45 degrees, the *sine* of whose double is *Radius*,. Likewise that the *Ranges* equally distant above and below 45 are equal, as

are the *sines* of all doubled *Arches*, to the *sines* of their doubled *Complements*.

Prop. VII. The *Altitudes* of *Projections* made with the same *Velocity*, at several *Elevations*, are as the *versed sines* of the doubled *Angles* of *Elevation*: As c is to s :: so is $\frac{p s c}{r r}$

$=$ GB to $\frac{p s s}{r r} =$ BF, and $UK = RU = \underline{BF}$, the *Altitude* of the

Projection $= \frac{p s s}{4 r r}$. Now by the foregoing ⁴*Lemma* $\frac{2 s s}{r} =$ to the

versed sine of the double *Angle*, and therefore it will be as *Radius*, to *versed sine* of double the *Angle* FGB, so an 8th of *Parameters* to the height of the *Projection* VK; and so these heights at several *Elevations* are as the said *versed sines*, Q. E. D.

Corollary.

From hence it is plain, that the greatest *Altitude* of the perpendicular *Projection* is a 4th of *Parameter*, or half the greatest *Horizontal Rang*; the *versed sine* of 180 degrees being $= 2 r$.

Prop. VIII. The *Lines* GF, or times of the flight of a *Project* cast with the same degree of *velocity* at different *Elevations*, are as the *sines* of the *Elevations*.

As c is to r :: so is $\frac{p s c}{r r} =$ GB by the 6 *Prop.* to $\frac{p s}{r} =$ GF, that is as *Radius* to *sine* of *Elevation*, so the *Parameter* to the line GF; so the lines GF are as the *sines* of *Elevation*, and the *Times* are proportional to those *Lines*; wherefore the *Times* are as the *Sines* of *Elevation*: Ergo constat propositio.

Prop. IX. Problem. A *Projection* being made as you please, having the *Distance* and *Altitude*, or *Descent* of an *Object*, through which the *Project* passes, together with the *Angle* of *Elevation* of the line of *Direction*; to find the *Parameter* and *Velocity*, that is (in Fig. 2.) having the *Angle* FGB, GM, and MX.

Solution. As *Radius* to *Secant* of FGB, so GM the distance given

given, to GL; and as Radius to Tangent of FGB, so GM to LM. Then LM—MX in heights, or +MX in descents; or else MX—ML, if the direction be below the Horizontal-line, is the fall in the time that the direct impulse given in G would have carried the Project from G to L=LX=GY; then by reason of the Parabola; as LX or GY, is to GL or YX, :: so is GL to the Parameter sought. To find the Velocity of the Impulse, by Prop. 2. & 4, find the time in seconds that a body would fall the space LX, and by that dividing the line GL, the Quote will be the Velocity, or space moved in a second sought, which is alwaies a mean proportional between the Parameter and 16 feet 1 inch.

Prop. X. Problem 2. Having the Parameter, Horizontal distance, and height or descent of an Object, to find the Elevations of the line of direction necessary to hit the given Object; that is, having GM, MX, and the greatest Randon equal to half the Parameter; to find the Angles FGB.

Let the Tangent of the Angle sought be =t, the Horizontal distance GM=b, the Altitude of the Object MX=h, the Parameter=p, and Radius=r, and it will be,

As r to t, so b to $\frac{tb}{r}$ = ML and $\frac{t}{r}b + h$ in ascents = LX, and $\frac{p}{r}tb + ph$ = GL quad. = XY quad. ratione Parabola; but

$bb + \frac{tt}{r}r = GL$ quad. 47. 1. Euclid. Wherefore

$\frac{p}{r}tb + ph = bb + \frac{tt}{r}r$ which Equation transposed, is

$\frac{tt}{rr} = \frac{p}{r}b + ph - bb$, divided by bb is

$\frac{tt}{rr} = \frac{p}{r}b + \frac{ph}{bb} - 1$. this Equation shews the Question to have two Answers, and the Roots thereof are $\frac{t}{r} = \frac{p}{2b} +$

$\sqrt{\frac{pp + 4ph}{4bb}} - 1$ from which I derive the following Rule.

Divide half the *Parameter* by the Horizontal distance, and keep the Quote; viz. $\frac{p}{2b}$ then say, as *square* of the *distance*

given to the half *Parameter*, so half *Parameter* \mp double height descent to the *square* of a *Secant* = $\frac{pp \mp 4ph}{4bb}$

the *Tangent* answering to that *Secant*, will be $\sqrt{\frac{pp \mp 4ph}{4bb} - 1}$

or rr : so then the sum and difference of the afore-found *Quote*, and this *Tangent* will be the Roots of the *Equation*, and the *Tangents* of the *Elevations* sought.

Note here, that in *Descents*, if the *Tangent* exceed the *Quote*, as it does when ph is more than bb , the *direction* of the lower *Elevation* will be below the *Horizon*, and if $ph=bb$, it must be directed *Horizontal*, and the *Tangent* of the upper *Elevation* will be $\frac{p}{b}r$: Note likewise, that if $4bb+4ph$ in *ascents*, or $4bb-4ph$ in *descents*, be equal to pp , there is but one *Elevation* that can hit the *Object*, and its *Tangent* is $\frac{p}{2b}r$ and if $4bb+4ph$ in *ascents*, or $4bb-4ph$ in *descents*, do exceed pp , the *Object* is without the reach of a *Project* cast with that *Velocity*, and so the thing impossible.

From this *Equation* $4bb \mp 4ph = pp$ are determined the utmost limits of the reach of any *Project*, and the Figure assigned, wherein are all the *heights* upon each *Horizontal distance* beyond which it cannot pass; for by reduction of that *Equation*, h will be found = $\frac{1}{4}p - \frac{bb}{p}$ in *heights*, and $\frac{bb}{p} - \frac{1}{4}p$ in *descents*; from whence it follows, that all the Points h are in the *Curve* of the *Parabola*, whose *Focus* is the Point from whence the *Project* is cast, and whose *Latus rectum*, or *Parameter ad Axem* is $=p$. Likewise from the same *Equation* may the least *Parameter* or *Velocity* be found capable to reach the *Object*

Object proposed ; for $bb = \frac{1}{2} pp \mp pb$ being reduced $\frac{1}{2} p$ will be $= \sqrt{bb + hb} \pm b$ in ascents, which is the *Horizontal*
in descents,

rang at 45 degrees, that would just reach the *Object*, and the *Elevation* requisite will be easily had ; for dividing the so found *Semi-parameter* by the *Horizontal distance* given b , the *Quote* into *Radius* will be the *Tangent* of the *Elevation* sought. This Rule may be of good use to all *Bombardiers* and *Gunners*, not only that they may use no more Powder than is necessary, to cast their *Bombs* into the place assigned, but that they may shoot with much more certainty, for that a small Error committed in the *Elevation* of the *Piece*, will produce no sensible difference in the fall of the Shot : For which Reasons the *French Engineers* in their late Sieges have used *Morter-pieces* inclined constantly to the *Elevation* of 45, proportioning their Charge of Powder according to the distance of the *Object* they intend to strike on the *Horizon*.

And this is all that need to be said concerning this *Problem*, of Shooting upon *hights* and *descents*. But if a *Geometrical* construction thereof be required ; I think I have one, that is as easy as any can be expected, which I deduce from the forgoing *Analytical Solution*, viz. $\frac{t}{r} = \frac{p}{2b} \pm \sqrt{\frac{1}{2} \frac{pp \pm pb - bb}{bb}}$,

and tis this. Having made the right *Angle* LDA , *Tab. I. fig. 4.* make $DA, DF = p$, or greatest *Rang*, $DG = b$ the *Horizontal distance*, and $DB, DC = h$, the *Perpendicular hight* of the *Object* ; and draw GB , and make $DE =$ thereto. Then with the *Radius* AC and center E sweep an Arch, which if the thing be possible, will Intersect the line AD in H ; and the line DH being laid both waies from F will give the points K and L , to which draw the lines GL, GK ; I say the *Angles* LGD, KGD are the *Elevations* required for hitting the *Object* B . But note that if B be below the *Horizon*, its *descent* $DC = DB$ must be laid from A , so as to have $AC =$ to $AD + DC$. Note likewise, that if in *descents* DH be greater than FD , and so K fall below D the
Angle

Angle KGD shall be the depression below the *Horizon*: Now this Construction so naturally follows from the *Equation*, that I shall need say no more about it.

Prop. XI. To determine the force or *Velocity* of a *Project*, in every point of the *Curve* it describes.

To do this we need no other *præcognita*, but only the third Proposition, *Viz.* that the *Velocity* of *falling Bodies*, is double to that which in the same time, would have described the space *fallen* by an equable motion: For the *Velocity* of a *Project*, is compounded of the constant equal *Velocity* of the impressed motion, and the *Velocity* of the *fall*, under a given *Angle*, *viz.* the complement of the *Elevation*: For instance, in *Fig. 2*, in the time wherein a project would move from G to L, it descends from L to X, and by the third Proposition has acquired a *Velocity*, which in that time would have carried it by an equable motion from L to Z or twice the descent L X; and drawing the line G Z, I say the *Velocity* in the point X, compounded of the *Velocities* G L and L Z under the *Angle* G L Z, is to the *Velocity* impressed in the point G, as G Z is to G L; this follows from our second *Axiome*; and by the 20 and 21. *Prop. lib. I, conic. Midorgii*, XO parallel and equal to G Z shall touch the *Parabola* in the point X. So that the *Velocities* in the several points, are as the lengths of the *Tangents* to the *Parabola* in those points, intercepted between any two *Diameters*: And these again are as the *Secants* of the *Angles*, which those *Tangents* continued make with the *Horizontal* line G B. From what is here laid down, may the comparative force of a *shot* in any two points of the *Curve*, be either *Geometrically* or *Arithmetically* discovered.

Corollary.

From hence it follows, that the force of a Shot is alwaies least at U, or the *Vertex* of the *Parabola*, and that at equal distances therefrom, as at T and X, G and B its force is alwaies equal, and that the least force in U is to that in G and B, as

B, as *Radius* to the Secant of the *Angle* of *Elevation* F G B.

These *Propositions* considered, there is no question relating to *Projects*, which by the help of them may not easily be Solved; and tho' it be true that most of them are to be met withal, in *Galileus*, *Torricellius* and others, who have taken them from those Authors, yet their Books being Forreign, and not easy to come by, and their *Demonstrations* long and difficult, I thought it not amiss to give the whole *Doctrine* here in *English*, with such short *Analytical* Proof of my own, as might be sufficient to evince their Truth.

The Tenth *Proposition* contains a *Problem*, untouch't by *Torricellius*, which is of the greatest use in *Gunnery*, and for the sake of which this *Discourse* was principally intended; It was first Solved by Mr. *Anderson*, in his Book of the Genuine use and effects of the *Gunn*, Printed in the Year 1674; but his Solution required so much Calculation, that it put me upon search, whether it might not be done more easily, and thereupon in the Year 1678 I found out the rule I now publish, and from it the *Geometrical* Construction: Since which time there has a large *Treatise* of this Subject Entituled, *L'art de jetter les Bombes*, been Published in *France* by *Monsieur Blondel*, wherein he gives the Solutions of this *Problem* by *Messieurs Bont, Romer* and *de la Hire*; But none of them being the same with mine, or in my Opinion more easy, and most of them more Operose, and besides mine finding the *Tangent*, which generally determines the *Angle* better than its *Sine*, I thought my self obliged to Print it for the use of all such, as desire to be informed in the *Mathematical* part, of the Art of *Gunnery*.

Now these rules were rigidly true, were it not, as I said before, for the Opposition of the Medium, whereby not only the direct impress Motion is continually retarded, by likewise the increase of the *Velocity* of the fall, so that the spaces described thereby, are not exactly as the squares of the times: But what this Opposition of the *Air* is, against several *Velocities*, *Bulks*, and *Weights*, is not so easy to determine. 'Tis

Certain

certain that the weight of *Air*, to that of *Water*, is nearly as 1 to 800, whence the weight thereof, to that of any *Project* is given; tis very likely, that to the same *Velocity*, and *Magnitude*, but of different matter, the *Opposition* should be *reciprocally* as the weights of the shott; as likewise that to shott of the same *Velocity* and matter, but of different Sizes, it should be as the *Diameters reciprocally*: whence generally the *Opposition* to shott with the same *Velocity*, but of differing *Diameters*, and *Materials*, should be as their *Specifick Gravities* into their *Diameters reciprocally*; but whether the *Opposition*, to differing *Velocities* of the same shott, be as the *Squares* of those *Velocities*, or as the *Velocities* themselves, or otherwise, is yet a harder Question. However it be, tis certain, that in large Shott of *Mettal*, whose weight many Thousand times Surpasses that of the *Air*, and whose force is very great, in proportion to the *Surface* wherewith they press thereon; this *Opposition* is scarce discernable: For by several *Experiments* made with all Care and Circumspection with a *Morterpeice* Extraordinary well fixt to the *Earth* on purpose, which carried a Solid Brass Shott of $4\frac{1}{2}$ Inches *Diameter*, and of about 14 Pound weight, the *Ranges* above and below 45 *Degrees* were found nearly equal; if there were any difference, the under *Ranges* went rather the farthest, but those differences were usually less than the Errours committed in ordinary *Practice*, by the unequal Goodness and Dryness of the same sort of *Powder*, by the Unfitness of the *Shott* to the *Bore*, and by the Loosness of the Carriage.

In a Smaller *Brass-Shott* of about an Inch and half *Diameter*, cast by a *Cross-Bow* which ranged it, at most about 400 foot, the Force being much more Equal than in the *Morterpeice*, this difference was found more Curiously, and Constantly and most Evidently, the under *Ranges* out went the upper. From which Trials I conclude, that altho' in small and light *Shott*, the *Opposition* of the *Air*, ought and must be accounted for; yet in *Shooting* of Great and Weighty *Bombs*, there need be very little or no allowance made; and so these *Rules* may be

be put in *Practice* to all Intents and Purposes, as if this *Impediment* were absolutely Removed.

*An Account of an Experiment shewn before the Royal Society, of Shooting by the Rarefaction of the Air :
By Dr. D. Papin, R. S. S.*

WHereas ordinary Wind-Guns do their Effect by the Compression of the Air. *Otto Ghericke* hath found a new Sort that shoots by Rarefaction ; and he hath Publisht that device at large in his Book about *Pneumatick Experiments*, but he doth not express how strong was the Effect. I have therefore had the Curiosity to try it my self by another Contrivance, which I take to be better than his : First, because I can make a Rarefaction much more perfect than he could do. Secondly, because his Device could not be used but for Guns of a small bore ; but my way may be apply'd to the biggest bore that can be made by Workmen : So that one might by this means throw up vast Weights to a great distance.

A A is a Pipe very equal from one end to the other.

B B a small Pipe solder'd to a Hole near the end of the Pipe A A, and apply'd to the Plate of the *Pneumatick Engine*.

C C C C some kind of Stool to bear up the hinder part of the Pipe A A.

D. a peice of Lead fitted to the bore of the pipe A A.

The pipe A A is to be shut at both ends by *Valves* outwardly apply'd, and so the said pipe A A, though never so big, may be exhausted of Air by means of the *Pneumatick Engine* : Which done, the *Valve* towards D must be suddenly open'd, so that the whole pressure of the *Atmosphere* acting upon the Lead D may drive it along the pipe A A with

such a swiftness, that it will be able to carry it to a great distance : And because such a *Valve* shutting a great hole would prove very difficult to be opened, when the pipe A A is of a great Bore, the aperture towards D may be left much smaller than the pipe ; the swiftness of the Air being so great, that even through a pretty small aperture, it presses the lead D as freely almost as if the whole Bore was quite open.

Having prepared a Barrel carrying a lead of 2 ounces, the Experiment was shewn before the *Royal Society*, and the Effect was found very considerable, the force being little less than that of the *Wind-Gun* by compression ; the same experiment being afterwards repeated with a longer Barrel, 'twas found that the length in this way of shooting was very little, if any advantage.

*Part of a LETTER from Dr. Salomon Reisel,
Chief Physician to the Duke of Wirtemberg, about an
extraordinary Tincture given to a Stone : Stutgardiae,
Febr. 120. 1686.*

A Urifaber Stutgardianus, qui & gemmis & Metallicis typis nummorum cudendorum insculpendis artificiosus est, nomine *Christophorus Muller*, Anno 1685, aurum aqua regis solutum, oleo *Tartari* præcipitatum atque edulcoratum, quod aurum fulminans dicunt, dum in scutella, quam Maturellam vocant, ex lapide Chalcedonico coloris unici pellucidi onychini seu Cornei, vitro pro fusione præparato rubro mixtum, & aqua fontana imbutum tereret, ad facienda Encausta seu smalta ; de quibus *Anton. Neri* vertente *Andrea Frisio*, egit lib. 6. *Artis Vitrariae* ; invenit iterato tertium eodem labore : quod color pulveris istius puniceus, qui per dies aliquot siccatus in vasculo manserat, quousque inter terendum

rendum etiam ad marginem effluxit, relictis tamen puris hinc inde spatiis Onychini coloris, durissimam hanc gemmam, quæ linam spernit, ita profunde penetraverit, non tantum in scutella, sed & ipso pistillo, & distinxerit maculis atque circulis sat ordinate ductis, ut color hic neque simplici aqua, neque lixivio, vel acriori alio liquore potuerit deleri, & quidem sine polituræ elegantioris detrimento.

Talis itaque tinctura per repetitas trituras dicti pulveris tentata denuo aliquoties, in similis coloris alio Vasculo, neque vero apparuit postea ut antea nunquam. Sed hoc imprimis circa tinctionem hujus vasculi observandum est, quod secundum texturam gemmæ, tam nudo quam armato oculo, in tincta interna, & sincera externa parte vasis, notentur fibræ seu ductus circulares, juxta quos, bracteis succi lapidei novi per intervalla impositis, in ejusmodi molem excrevisse credendum est; uti Bezoar aliique lapides laminis super accrescentibus augentur, & ligna, in quorum ultimorum trunco, circuli seu annuli designant succi annui numerum & incrementa: adeo ut hic, purpureus ille color lineis pallidioribus & obscurioribus, prout vel densiores vel rariores poros, molliorem vel duriorum texturam offendit, circulares ambitus circa verticem aliquem, veluti circa medullam seu cor, ut appellant, aut granum aut paleam in aliis lapidibus & lignis, signaverit; intermistis quoque hinc inde maculis & spatiis obscurioribus. Veluti *Illustr. Boyle, Specim. de Orig. & Virt. Gemmarum*, §. 1. pag. 22, 23, in Adamante & Granatis acies & commissuras tenuium bractearum aut planorum observavit; quod granum artifices seu planam contexturam non dissimilem fissilitati ligni vocant.

Jam vero tingi posse quoque Marmora & Alabastra & Ossa per lixiviatores & acres succos, hinc inde scriptum est: quod fortassis & de Gemmis sperandum est, quando *Rob. Boyle Cit. §. 2. pag. 123.* ex iis tincturam manifestam extractam esse scribit, alibi, p. 43. & 190. per vapores minerales tinctos esse crystallos petrosos, atque pag. 45. ipsum Sapphirum per vapores subterraneos.

Cum

Cum denique ex observatione nostra manifestum sit, revera tinctam esse gemmam Chalcedoniam, quamvis fortuito acciderit, neque repetito processu simile quid evenerit, merebitur tamen meditationem, an ex astrorum fluxu, alia-ve abscondita potius vi venerit, & tentamen, an ex mixtura salium & succorum acrium possit imitando produci ejusmodi Tinctura, & quidem sine Igne, ut splendor & Pelluciditas gemmæ non destruat, durities autem maneat, adeoque ipsa gemmæ pretiositas non tantum servetur, sed & per tincturam novam crescat.

Hujus Tincturæ figuram & modum, si forte quem delectet, addere placuit, qualis noctu opposita Candelæ visa fuit, aliquomodo nec satis accurate delineatum. Tab. i. Fig. 6.

A CATALOGUE of *Simple and Mixt Colours*,
with a *Specimen* of each Colour prefixt to its proper
Name: By R. WALLER, Fellow of the Royal
Society.

HAVING sometime since seen a TABLE of the *Simple Colours* made use of in *Limning and Painting*, Printed in the Year 1680, at *Stockholm*; I have here endeavoured to give a more *Philosophical*, and useful one by the addition of some *mixt Colours*: Not that I pretend to give the *Shades* of all the *mixt Colours*, which were indeed infinite as the *Compositions* and *Proportions* of them may be unlimited; but I have mixt each of the *Simple Yellows* and *Reds* with each of the *simple Blues*, and these *Mixtures* give most of the *mean Colours*, viz. *Greens*, *Purples*, &c. To know what each of these *mixt Colours* is compounded of, you need but look to the Top of the Table directly over the Colour enquired after, where you may find the One *Ingredient*, and at the Side in
the

the same Row, the other. As the *P. pyrinjay-green* is made of *Blew Bice* and *Camlotia*, an equal weight of each. I chose *Weight* rather than *Measure*, because the heavier *Colours* have generally the more *Body*, and therefore come nearest to an *Equality* that way. I have added the *Latin, Greek, French,* and *English* Names that I knew, which the more skilful *Reader* may supply where wanting. I propose to my self that this *Table* will be of some use and advantage in the describing of the *Colours* of *Natural Bodies*, which may be done by this *Table*, and represented more nearly to the *Reader* provided with one of the same *Tables*, with less ambiguity, I think, than is usual: A *Standard* of *Colours* being yet a thing wanting in *Philosophy*. Thus to describe a *Plant*, it may be seen which of the *simple* or *mixt Colours* comes nearest to it, and then the *Word* affixt to that *Colour* may be made use of, which the *Reader*, if desirous, may look in his *Table*, and find together with the *Pattern* thereof.

The Table of Colours is to be Inserted after this Leaf, which ought to be done with a Guard and a White-leaf between after the Book is bound, lest otherwise the Colours by beating stick together.

A short

*A Short Description of the Simple Colours specified
in this Table.*

1. **S**panish White made of Chalk and Alumn burnt together.

2. I take the *Lapis Armenius* to be the blew Bice fold in the Shops, for it is light and friable; formerly brought out of *Armenia*, now from the Silver Mines of *Germany*, called *Melochites*, in high Dutch *Berghlaw*.

3. *Ultramarine* is made of the blewest *lapis Lazuli*, which is freest from Gold-veins, by Calcination; the method of preparing it being too large for this place, may be seen in Doctor *Merret's* ingenious Notes upon *Neri's* Art of Glass, lib. 7.

4. *Smalt* is made of *Zaffer* and *Pot-ashes*, calcined together in a Glass-furnace. Dr. *Merret* ib.

5. *Litmase*, or *Litmose*, I suppose the Juice of a Plant.

6. *Indigo* said by *Pliny* to be brought from *India*: a kind of Mud adhering to the Froath about Reeds, and that when tryed with a Coal, the true burns with a Purple-flame, and smells of the Sea: *Linschoten* says, it is called *Anil*, that it grows in *Carnatia*, and is a Plant like *Rosemary*, which is gathered and dryed, then wetted with fair Water, and beaten to a Mud; this Operation being repeated, it is dryed and fitted for use, cap 69.

7. *Indian Ink*, its Use known to *Pliny*, tho' not its Composition; which is yet undiscovered, except it should be burnt Rice, as hath been thought.

So much for the *Blews* at the Head of our Table; the *Yellows* and *Reds* made use of, are these that follow.

1. *Ceruse* is the Rust of *Lead* made by a vaporous Calcination; *Pliny* writes thus of it in the 34. lib. cap. 18. *Ceruse*, or *Psmythium* is made in the Plummers Shops; of small
Plates

Tabula Colorum Sim - - - - - pli - - - - - ces									
tam Mixtorum quam Simplicium.			Indicium.			Astramentum Sim			
Quadrilinguis una cum			Diola ceus. Ιόλιδιμος			Indicus. Ινδικος.			Coracius. Κορ
Regiæ Societati Londin.			Diola et C.						Ra
D.D.D. a Ric. D.			- x - - - - - ti.						
Cerussa		Lacte Blanch						Plumbeus Co. de plomb. Léa	
- ces. - - - - - x - - - - - ti.									
Masticot		Limo Limon	Black & blen					Nigellus Υπομ Blé	
Gutta Gambæ		Aurea Coeur							
Ocra		Lutea C d'or							
Auripig- mentum.		Citrin							
Umbræ		Fusc Brun			Murinus.	Moussé C.		Castaneus. Ces	
- ces. - - - - - Mix - - - - - ti.									
Minium		Ignis C du						Pallus. Earth	
Ocra usta		Ruffe						Ethiopicus. Αἰθ Negro	
Cinnabaris		Min du De	Lindogypsius. Grie de lion.					Fuliginus. Νιφ Soot	
Carmin		Cocci C d'E	Purpureus. Πορφύρεος C d'oupr. Purple		Astrabapticus				
Lacca		Rubi						Furvus.	
Sanguis Draconis		Sangu C du						Prelus.	
Rubrica		Terr			Hibernus More' Murrey.			Ater. Gal B.	
Astramentum Fuliginosus		Piceus C du	Elbidus. Dark gray					Niger. Μέν Black	

Tabula Colorum Chymicorum
tam Mixtorum quam Simplicium,
Quadrilinguis una cum Speciminibus adjectis
Regiæ Societati Londinensi humillime
D.D.D. a Ric. Waller S.R.S.

Tabula Colorum Physiologica.												Ca - - - - - ru - - - - - le - - - - - i												Sim - - - - - pli - - - - - ces															
tam Mixtorum quam Simplicium.												Candidi Hispan.				Montanum.				Cyprium.				Smalt.				Litmase.				Indicum.				Astramentum Sim			
Quadrilinguis una cum Speciminibus adjectis												Niveus.				Glastineus				Cyaneus.				Lazurinus				Diolaaceus.				Indicus.				Coracineus.			
Regiæ Societati Londinensi humillime												Snow wh.				Watercol.				C. d'azure Azure				Diolet C.				Indikos.				Kor							
D.D.D. a Ric. Waller P.R.S.																																							
												Ca - - - - - ru - - - - - le - - - - - i				Mi - - - - - x - - - - - ti.																							
Cerussa				Lacteus.				Argenteus.				Turcinus.				Canileus				Hyacinthinus								Plumbeus											
				Blanch come du lait Milk wh.				Silver C.				Turcois C.				Skid Col.				Jacynth C.								Co. de plomb. Lead											
ces.												Lutei mixti.				Di - - - - - ri - - - - - des												Mi - - - - - x - - - - - ti.											
Masticot				Limonius				Paleus.				Lymatilis.				Saligneus				Thalassinus				Linous				Nigellus											
				Limon C.				Strand C.				May C.				Millon gr.				Sea gr.				Black & blue				Yon											
Patta				Aureus.				Luteolus.				Pittaceus.				Herbeus				Porraceus.																			
Camba				Chrysoides				Icthyoides				Poppinjay gr.				Grass green				Leeke C.																			
				C. d'or. Gold colour.				Yellowish.																															
Uenta				Luteus.				Electicus.								Ditreus.																							
				C. d'or. Gold Col.				Amber C.								Glass C.																							
Auripigmentum				Citrinus.				Byssinus.																															
				Kitrinos				Bussinus.																															
				Orange C.				Ransilke C.																															
Umbrina				Fuscus.				Subfuscus.																				Murinus.											
				Brun.				Dun.																				Mouse C.											
ces.												Rubei mixti.				Pur - - - - - ru - - - - - re - - - - - i												Mix - - - - - ti.											
Minium				Ignis.				Gilvus.																								Pullus.							
				C. du feu. Fire Col.				Brick C.																								Earth							
Ochra				Ruffus.				Halvus.				Badus.																				Ethiopicus.							
usta				Carrot C.				Sorrel.				Bay.				Bay.																Negro-L							
Cinnabaris				Minialis.				Carneus.																Lividopurpureus.								Fuliginus.							
				du Demillon.				Carnation																Grie de lion.								Soot							
Carmen				Coccinus.				Roseus.				Molochinus.				Ostrinus.				Dibaphus.				Purpureus.				Astrabapticus											
				C. d'Escarlata. Crimson.				Rosey				Mallons C.				Purple Royal				Purple ingrain				C. de Pourpr. Purple.															
Lacca				Rubinus.				Coryophylleus.				Pericus.				Amathistinus.				Paonaceus.								Fumus.											
				Ruby-red.				Pink C.				Peach Col.				Amethyst Co.																							
Sanguis				Sanguineus.																												Prælus.							
Draconis				C. du Sang.																																			
				Blood-red																																			
Rubrica				Ferrugineus.												Baeticus.												Niberus.				Ater.							
				Rust C.												Bronze												More' Murrey.				Coal &							
Astramentum				Ficus.				Griseus.				Canus.				Cinereus.				Ferreus.				Ebrius.								Niger.							
Fuliginosum				C. du poix.				Gray				Hoary				Ash-col.				Iron-gray				Dark-gray								Black							

Plates of Lead laid upon a Vessel of very strong Vinegar, what falls into the Vinegar is taken out, and dryed in the Sun : and in the 35 Book, Chap. 6. he says it was made at Rome of burnt *Mar-le-flint* quench'd in Vinegar.

2. *Masticot* is a kind of improper *Calx* of *Tin*.

3- *Gutta Gamba*, or *Cambodia*, the inspissated Juice of a Plant, not well known, it comes from both the *Indies*. Some think it the Juice of *Euphorbium*; others *Scammony*, or *Tithimal*; others *Ricinus*; others refer it to the greater *Cataputia*, *Esula*, or the Flowers of the *Indian Ricinus*, and will have it coloured with *Turmerick*: as *Scroder*.

4. *Oker* a kind of Natural Earth, there are two sorts thereof, the one Native formerly brought out of *Attica*, now from *Dacia* and *Hungaria*, and from many places of *England*, especially in the Forreſt of *Dean*: The other a factitious substance of *Lead* burnt and quench'd in *Vinegar*. In *Pliny's* time it was made of *Rubrica*, or *Reddle* burnt.

5. *Orpiment*, a fat inflammable *Mineral*, juſtly ranked amongſt *Poyſons* for its extream Corroſive quality. *Pliny* ſays it was dug up in *Syria* on the Surface of the Earth; and that the Emperor *Caligula* had hopes of getting *Gold* out of it; wherefore he cauſed 14 Pounds of it to be tryed, which afforded him very good *Gold*, but in ſo ſmall a Proportion, that he loſt by the tryal.

6. *Umber* is a Native Earth.

7. *Red-lead*, a Colour unknown to the *Antients*, made of *Litharge* or burnt *Lead* by a Reverberatory Calcination, or of *Ceruſe* put in a Platter over the Fire, which muſt be continually ſtirred till it has acquired a *Red-lead* colour. Dr. *Charlton de Foſſ*.

8. *Burnt Oker* is the common yellow *Oker* burnt in the open fire.

9. *Cinnabar* or *Vermillion*. There are two ſorts; Native or the *Minium* of the *Ancients*, which is the *Mineral* that yields *Quickſilver*; whereof, and of *Sulphur* it chiefly conſiſts,

it is found in the Mines of *Istria*. This Colour was among the Ancient *Romans* used to sacred Purposes, and on Festivals *Jupiters* Face was painted therewith, as likewise the Bodies of those that entred in Triumph. The factitious *Cinnabar* is that which we now use; and is made by a sublimation of *Mercury* and *Sulphur*.

10. *Carmin* made of *Cochineel*.

11. *Lake*, thought to be an *Arabick* word: It is made of Flocks dyed, or shavings of *Scarlet-cloath*, or of the *Cochineel Insect*, or else of *Kermes-berries*, their Tincture being extracted with a Lye of *Pot-ashes*, and then precipitated with a Solution of *Rock-alum*. After the same manner a *Lake* may be made of any Plant or Flower; a more exact Information touching this matter, may be had in Mr. *Boyle's Treatise of Colours*, Part. 3. Exp. 49. and Dr. *Merret's Notes on Neri's Art of Glass*. lib. 7. There is also another sort of *Lake* made of *Gum-ac*, by extracting its Tincture with *Urine*. Dr. *Merret*, *ibidem*.

12. *Sanguis Draconis* is the Gum of a Tree which looks like dried Blood, 'tis brought out of several places in the *East Indies*; and the Tree which produces it is very well described in the *Hortus Malabaricus*.

13. *English Reddle* or *Ruddale*, is found in many places of *England*, amongst the rest near *Witney* in *Oxford-shire*. Dr. *Plot's Hist. of Ox.* c. 3.

14. *Lamp-black*, by *Pliny* thus described: It is made of the Soot of *Rosin* or *Pitch* burnt, Houses being built on purpose for it, that keep in the Smoak. Its Use is in *Writing-books*, lib. 35. cap. 6.

In usum Exterorum visum est Præfatiunculam hanc atque Catalogum Colorum Latinitate donare.

CUM aliquando viderim *Nomenclaturam* Colorum simplicium Trilinguem *Stockholmie* editam per *D. Sl. Brenner*; mihi in mentem venit opus me præstiturum *Genio*, ac fini *Regiæ Societatis*, nec absonum, nec inutile, si talis, non modo *Simplicium*, verum etiam *Mixtorum Colorum Tabulæ* conficiendæ modum excogitare potuerim: magis autem fore gratum si cuique *Vocabulo Specimen Coloris* apponi possit; quod Amice *Lector* hic tandem effectum vides.

Constructionem Tabulæ quod spectat, in *Capite* omnes *Cærulei* Simples, & *Primarii* apponuntur, & ad *Latus* primo *Luteos*, ac deinde *Rubeos* affixos vides, cum *speciminibus* propriis, & *nominibus* in *Officinis* notioribus: Cæteri, viz. *Pallidiores Cærulei, Flavi, Rubeique* necnon *Virides, & Purpurei* omnes, e mixtura *Simplicium* æquis partibus *Orti*, reliquam *Tabulæ* partem complent. puta *Specimen Colori Herbeo* affixum, compositum est ex æquo pondere *Cyprii* ad *Caput Tabulæ* videnti, & *Gutta Gambæ* ad *Latus*, intime *Commixtorum*: Sic dicendum de cæteris. *Speciminibus* etiam adjeci nomina *Latina, Græca, Gallica, & Anglica*, saltem quæ mihi nota; quæ autem desiderantur magis verborum gnarus apponas *Curioſe Lector*, ac nostro defectui subministres *Rogo*.

Ad *usum* vero hujusce quod attinet, non leviuſculum hinc enaturum confido: restat enim hucusque quid *Desideratum* nempe *justa Colorum statera*. Jam si quis *Plantarum*, vel *Animalium* *Integumentum* describere velit, ope hujus *Tabulæ* minimo *Labore*, sine ulla *Ambage*, vel *Ambiguitate* rem conficiet, idemque genuinis quasi depictum coloribus, *Lectoris* eadem instructi *Tabulæ* oculis subjiciet. Exempli gratia, *Gentianellæ* flos colore est *azurino*, exterius in *saligneum* vergente, hujusque plantæ folia prope *Herbei* sunt coloris.

Hoc qualecunque *Tentamen* in meliorem partem accipias, studioque nostro tibi subserviendi fruaris foeliciter, & faveas candide.

Vale.

Sequitur Pigmentorum Simplicium in hac Tabula exhibitorum Descriptio aliqualis.

1. *Candidum Hispanicum* fit ex *Creta alba* et *Alumine* in Crucibulo simul calcinatis.

2. *Montanum*, vel *Lapis Armenius*, levis est & friabilis: olim ex *Armenia* deferebatur, hodie vero reperitur in *Germania* in Argenti fodinis; dicitur etiam *Melochitis*, *Bergblaw*. Scrod. Pharm. Med. Chym. l. 4. Claf. 4. §. 465.

3. *Cyprium*, vel *Ultramarinum* ex lapide *Lazuli*, seu *Cyano* per calcinationem fit. Hujus præparationis methodum cum nimis tædiofum foret hic percurrere, videas *D. Dris Merreti* Notas in Art. *Vitrariam Neri*. l. 7. c. 115.

4. *Smaltum* Efficitur calcinando in fornace *Zafferum*, una cum cineribus clavellatis. Modum exhibet *Ars Vitraria*. *Dr. Merret*, lib. 7. cap. 72.

5. *Litmas* vel *Litmos*, uti videtur, succus est plantæ alicujus inspissatus.

Indicum, Authore *Plinio* ex *India* provenit, constans limo quodam arundinum spumæ adhærescente; probatur carbone, sincerum enim reddit flammam excellentis purpuræ, ac dum fumat Odorem Maris redolet, l. 35. c. 6.

A *Linschoten* vero aliter describitur. *Anil*, vel *Indicum* in regione *Cambaiæ* fit, ex planta quadam *Rorimarino* simili; quæ carpitur, & exiccata, aqua denuo humectatur, ac tundendo maceratur, quo facto evaporatur aqua, ac pigmentum conficitur. *Linschot*. cap. 69.

Hodie vero in insula *Jamaica* et alibi in *Americanis* nostris *Coloniis* copiose provenit, ac ad hunc ferme modum præparatur.

7. *Atramentum Sinicum* vel *Indicum* *Plinio*, cui ignotum erat ex quo constabat; neque etiam nobis plane innotuit quid sit: a quibusdam vero creditur *Oriza* usta.

Hoc

Hoc sufficiat descriptioni *Cæruleorum* ad Caput *Tabulae* positorum. jam Pauca de *Luteis* & *Rubris* subjiciam.

1. *Cerussa* est *Ærugo Plumbi* per *Calcinationem* vaporosam. *Diosc.* l. 5. c. 103. De hac ita *Plinius*; *Cerussa* vel *Psimythium* fit ex laminis *Plumbi* tenuissimis super vas aceti asperrimi impositis, atque ita distillantibus iis, quod in vas decidit, ad solem siccatur, lib. 34. cap. 18. Idem testatur aliud genus *Roma* factum, cremato scilicet *Marmoroso* & restincto aceto, l. 35. c. 6.

2. *Masticot* est *Calx* quædam impropria sic dicta ex *Stanno* confecta. *Helm. de Lithi.* c. 1.

3. *Gutta Gamba*, succus inspissatus *Plantæ* minus notæ; ex *India* utraq; venit, juxta quosdam *Euphorbii*, alios *Ricini* vel *Tithimali*; vel *Scammonii* succus est. Sunt qui ad *Esulam*, & *Cataputiam* majorem, vel ad flores *Ricini* *Indi* originem ejus referunt, coloremque ex *Curcuma* conciliatum volunt. *Scrod. ib.* l. 4. c. 4. §. 465.

4. *Ochra*, *Terræ* species: duplex autem habetur, *Nativa*, quæ apud nos multis in locis reperitur, præsertim in *Saltu de Dean*. *Factitiæ* altera ex *Plumbo* adusto & in aceto extincto, facta vero est tempore *Plinii* ex *Calcinata Rubrica*: *Plin.* l. 35. c. 6.

5. *Auripigmentum*, *Arsenicum*. Minerale est pingue, & inflammabile, jure inter *venena* referendum propter insignem ejus qualitatem corrosivam. *Plinius* dicit in *Syria* effodi in summa tellure, & olim sperasse *Caligulam Imperatorem*, aurum exinde colligi posse; quamobrem excoqui jussit ad pond lib. 14. ex quo purum quidem Aurum elicuit, sed tam exigua quantitate, ut experimenti sumptus non rependeret.

6. *Umbria* Terra est *Nativa*.

7. *Minium factitium*, ignotum veteribus; Fit ex *plumbo* per calcinationem reverberatorii; vel ex *Cerussa* in *Patina* super ignem posita, ac continue *Rudicula* agitata, donec colorem *Minii* acquisiverit. *Dr. Charlton* de fossil.

8. *Ochra-usta*, *Ochra* est *nativa lutea* nudo igne adusta.

9. *Cinna-*

9. *Cinnabaris* Græcis *Miltos*, duplex est; *Nativa*, *Minium* Veterum: minera vero est e qua excoquitur *Hydrargyrum*, quæq; ex eo et *Sulphure* plurimum constat. copiose provenit in *Mercurii* fodinis *Istriensibus*. Color hic apud *Veteres Romanos* in sacros usus adhibebatur, eoq; *Jovis* simulachri faciem diebus festis illinere solebant, ut & *Triumphantium* corpora: *Plinio* veteres citante l. 33. c. 7. Ubi dicit *Romam* solummodo ex *Hispania* advectum fuisse. Altera *Factitia* ac nobis usitata, fit ex *Mercurio* cum *sulphure* sublimato. *Scrod.* l. 3. c. 15.

10. *Carmin* fit ex *Coccinella*.

11. *Lacca*, vocabulum creditur *Arabicum*, efficitur autem *Lacca* hæc ex *Coccino*, ex floccis *Scarlata* tinctis, vel ex *Coccinella*, vel ex granis *Kermes*, Lixivio cinerum *clavellatorum* extrahendo tincturam, quæ deinde solutione *Aluminis Rupei* præcipitatur: pari modo *Vegetabilium* quorumvis *Laccam* extrahas. Informationem pleniorẽ cupiens adeat. *Nob. D. Boyle Tract. de Color. Part. 3. Exp. 49. et Merreti Notas in Art. Vit. Neril. 7. c. 116. 119.* Alia etiam datur *Lacca* ex *Gummi-lac*, cujus tinctura *Urina humana* extrahitur. *Merret, ib.*

12. *Sanguis Draconis*, lachryma arboris cujusdam instar sanguinis Exiccati concreta; Ex *India* orientali advehitur, et arbor e qua *Lachryma* hæc exudat accurate describitur in *Hortu Malabarico*.

13. *Rubrica Anglica*, in multis *Angliæ* locis reperitur.

14. *Atramentum Fuliginosum*, nihil aliud est quam fuligo *Resine*, vel *Picis* concremata collecta, qua propter officinas ædificavere fumum illum non emittentes; olim ad *Atramentum Scriptorium* in usu erat. *Plin. l. 35. c. 6.*

An ESSAY towards the Recovery of the Jewish Weights and Measures, Comprehending their Money, by help of Ancient Standards compared with ours of England. By Richard Cumberland, D. D. in Octavo, London, 1686.

THE Learned Author of this *Treatise*, has with a great deal of Industry and Judgment, Collected the several Testimonies both Ancient and Modern, Sacred and Profane, that may give any light into the discovery of the Ancient *Jewish Weights and Measures*: In the doing whereof he relies chiefly upon the Tryals of Mr. *Greaves*, whose Integrity was never yet questioned, and who with his own hands compared our *English Standard Foot* with the several *Foreign Measures* our Author has occasion to use: The Book consists of Four Chapters, whereof the *first* by way of *Preface*, gives an account of the Method proper to be used in this Discovery. The *second* proves by many Arguments the likelihood that the *Jewish Ammah* or *Cubit*, was the same with the present *Egyptian Cubit*; to do which, he alledges that the usual Rise of *Nilus*, necessary for the fertilizing of *Egypt*, was in the days of *Herodotus*, as well as now, about 16 *Cubits*; whence he concludes, that the old *Cubit* of *Egypt* is not altered, but the Divisions on the *Nilometrion* are the same as in all Antiquity: Also that the constant necessity of Surveying their Lands, by reason the Annual over-flowing does Efface their Land-marks, obliged them to observe a constant *Standard* to avoid confusion. Next he alledges this *Cubit* not to have been altered by any *Conquest*; the *Babylonian Cubit* of Five *Palms* being shorter, and that of Six being the same; that their next *Conquerors* the *Greeks* and *Romans*, have their *Cubit* considerably shorter, and that the *Turks* their present

present Masters have not introduced theirs, which is much longer, as appears by Mr. Greaves. Lastly, He proves out of Greaves, that the side of the Great *Pyramide*, and the length of the *Tomb* therein, are measured by an even Number of such *Egyptian Cubits*; wherefore he concludes they were so designed at first; viz. the Side of the *Pyramide* to be 380 *Cubits*, and the length of the *Tomb* just Four, which carries with it a great shew of probability. This done, he proves the *Jewish Cubit*, the same with the *Egyptian Cubit*, by several probable Arguments; among which the chief seems to be, That the whole Nation of the *Jews* had been for so many years Subjects of *Egypt*, and carried undoubtedly away with them their *Weights* and *Measures*: and there is no Testimony or Reason to prove that the *Jews* have since altered them. Hence he concludes the Old *Scripture Cubit* 21, 9 Inches *English fere*, equal to what Mr. Greaves found the modern *Egyptian Cubit*: and so makes a *Table* of all the other *Measures*, whose proportions to the *Cubit* are agreed upon.

The *third Chapter* treats of the *Epha*, and the other *Measures* of Capacity, endeavouring to prove the *Content* of *Epha*, equal to $\frac{1}{2}$ of the *Ardub*, or *Cube* of the *Egyptian Cubit*; that is, Seven Gallons and half, and half Pint *Circiter*, or very near the *Cube* of a Foot *English*, and containing just 1000 Ounces *Averdupoize* of Water; for the which he produces such Authorities, and compares them so well together, that he has almost put it out of doubt; giving at last a *Table* of the *Contents* of all the other *Scripture-Measures* of Capacity, having a known relation to the *Epha*.

The *fourth Chapter* treats of the *Weights* and *Coyns* mentioned in *Scripture*; and having by Tryal as well as Authority found the Weight of *Shekel* just half the *Roman Ounce*, equal to the half Ounce *Averdupoize*, he determines its value 2 s. 4 d. $\frac{1}{2}$ and thence derives the value of the *Gold* and *Silver Talent*, weighing 3000 *Shekels*. Lastly, He recommends for a Universal Standard, the length of the *Pendulum* vibrating

ting *Seconds*, to be the *Hora x Terd*, which he says is 3 Foot $3\frac{1}{4}$ Inches *English*, following therein the Ingenious Mr. *Hugens* the first Proposer thereof. By the way, he takes notice of the Harmony that is between the *Measures* and *Weights* thus stated; for having the *Egyptian Cubit* given, the sixth part of its *Cule* is the *Epha*, the tenth thereof *Homer*, the tenth of that *Cotyla*, the tenth of which is an Ounce *Averdupoise* in Water, whose half is exactly the Weight of *Shekel*. The whole Book being made up of very rare Remarks, is well worth the perusal of the Curious Reader.

Note, That the Learned Dr. *Edward Bernard* in his late Account of *Weights* and *Measures*, agrees nearly in the Capacity of *Epha*, with what Dr. *Cumberland* has determined; for he makes the *Cube* of the *English Foot* to contain 76 l. Troy of Spring-water, and the *Epha*, or rather *Bath* to contain 75 such Pounds, so that it is a Pound less than the *Cube* of a *Foot English*, which Dr. *Cumberland* has stated about 12 Ounces of Water more than the said *Cube*: And whereas Dr. *Bernard* says, the *Epha* contains 9 Gallons, 'tis a plain mistake of the Printer, of 9 for 7; for the *Cube* of a *Foot*, which is by his own account greater than *Epha*, scarce holds 7 Gallons and half, such as by Statute are to contain 231 *Cube Inches*. As to the Value of *Shekel*, Dr. *Bernard* says, that none but *Bishop Usber* ever made it so little as 2 s. 5 d, which yet Doctor *Cumberland* has reduced to 2 s. 4 d. ∴

Ephemeris ad Annum a Nativitate Domini 1686, ad Longitudinem Urbis Londinensis; ex Novis Hypothesibus exactissime supputata, & Regiæ Societati dicata, Londini in Octavo. Impensis Gulielmi Cooper.

There being at this time a great want of *Ephemerides* of any tollerable exactness, several of our *Astronomers* were perswaded to undertake the Calculation of one for this
 E present

present Year, which they have done from *Tables* of their own, whose Numbers, by many years observation, have been found to answer with great preciseness to the Celestial Motions, the *Moon* only excepted; whose Motion, by reason of her manifold Inequalities, not being yet reduced to the Nicety of the rest of the *Planets*, 'twas thought needless to do any more than reduce her *Tychonick* place in *Argol*, to our *Meridian*, and Compute the true *Latitudes*. The several Persons concerned have promised a Continuation thereof for some years to come, which will make it valuable to all Lovers of *Astronomy*.

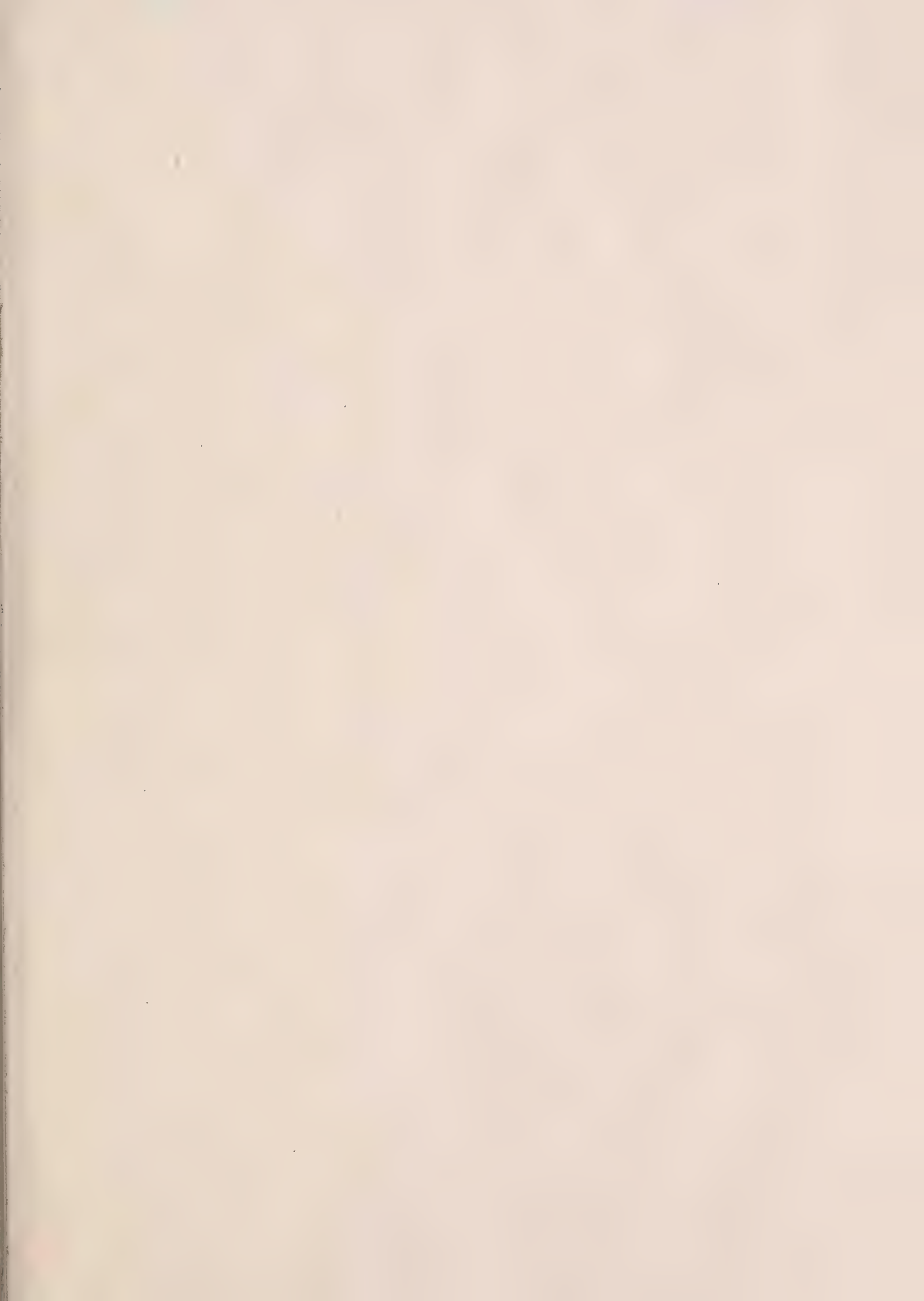
Imprimatur,

May 15. 1686.

S. PEPTS. R. S. Pr.

L O N D O N,

Printed by J. Streater, and are to be sold by Sam. Smith,
at the Sign of the *Princes's Arms* in *St. Paul's Church-yard*.



A diagram showing a vertical arrangement of spheres and a horizontal bar. A horizontal bar is positioned at the top, with a single sphere hanging from its center. Below this bar, another horizontal bar is shown, with a single sphere hanging from its center. Below this second bar, a vertical line extends downwards, ending in a cluster of three spheres stacked vertically. The entire arrangement is enclosed within a rectangular frame.

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PHILOSOPHICAL

TRANSACTIONS.

For March and April, 1686.

THE CONTENTS.

THE Preface. *An Account of a Voyage made by the Emperour of China into Corea and the Eastern Tartary in the Year 1682. Containing many Curious Observations and Discoveries, of the height of Mountains. Declination of the Compass, and of the Latitudes and Distances of several Places, through which he passed. A Relation of a second Voyage of the said Emperour into the Western Tartary containing an exact Account of the Country Government, Manners, and Customs of these People, and several Observations concerning the Miraculous Wall, and the Prodigious Height of some Mountains. An Explanation necessary to justify the Geography supposed in these Accounts. Some Observations and Conjectures concerning the Character and Language of the Chinese, Made by R. H. Fellow of the Royal Society, together with the Characters and Method of their Numbers, and the Letters and Strokes out of which, both the Radical and also the Compounded and Decompounded Characters are constructed: with a Specimen of three Varieties of Characters or ways of Writing, made use of by them, The Figure of the Roman Abacus, together with that of the Chinese now commonly made use of for the performing of all Arithmetical operations necessary for Trade.*

THE
P R E F A C E.

TArtary, and the North-East of China, being parts of Asia, the least known and hitherto the most fabulously described, I conceiv'd it would not be unpleasing to the Curious in England, to be furnisht with the Translation of two Letters published lately at Paris, which give a considerable Information concerning the present State of them. The Publisher Dedicated them to the French King, and affirms them to be the Letters of the Famous Father Verbieft, who is one of the 3 Fathers (*viz* Ludovicus Buglius, Gabriel Magellanus, and Ferdinandus Verbieft) that were left at Pekin to Sollicit the cause of Christianity, and who by his great Skill in Mathematick Learning obtained access to that Emperour, and thereby many Favours for himself and the other Missionaries; As appears by a Book Printed in the Chinese and Latine Character in Quam Cheu the Metropolis of the Province of Quam tum in China Anno. 1671.

But one Reason more of Printing this Translate, was to manifest by Experience, the great use of Mathematical Knowledge, which, by these, you will perceive highly esteemed in Countries where 'tis more difficult to be obtained then here, so that when no other means could procure entrance upon the skirts of that vast Empire of China, this alone has got admittance into the Metropolis of the whole Empire, nay, into the Pallace and Presence of the Emperour, with the practical parts of which knowledge, you will here find Him delighted and even captivated; And that this Learned Father, judges it the most effectual means to insinuate into the Minds also, of the most rude and ignorant (of all other things and parts of the World, but what their own Country affords) in order to propagate the Christian Religion. I shall not now add as a Confirmation of this Opinion, what to this effect we have long since
been

been informed of by the Historical Relations about China, but only take notice that besides this use, these Letters will give another, viz. Several Curious Mathematical and Physical Observations there made by the Author, who it seems well understood what would be beneficial to Europe as well as pleasing to the Chinese. To men so equalised with Mathematical knowledge, we owe the Discovery, of the before, unknown parts of the World, and from such we are to hope for the perfection of that knowledge, and the Discovery of the rest. I have upon this occasion added some inquiries concerning the Literature of that Country, they are but conjectures, grounded upon the perusal of some of their Books. A full Discovery is not pretended, however I hope they may serve as hints and incitements to others, who have better ability and other advantages to compleat it. We have hitherto not been admitted to the Skirts, but this Discovery when perfected, will lay open to us an Empire of Learning, hitherto only fabulously described; This will admit us to converse with the best and greatest of that Empire, that either are or ever have been; This will Discover a new Indian Mine and Treasure, and make a new Trade to bring it hither, which may not be unworthy, the consideration of our Honourable East-Indian-Company, As well as of several Learnd Men, who have leisure, and other opportunities to make further Progress in this Inquiry: To promote which, if these find acceptance, I shall add some further observations, together with the publication of one piece of their Philosophy, which is printed in their own Character, with the pronounciation and interpretation in Latine; which may supply a fit Subject for the Curious to practice upon, and give a tast of the Philosophy and of the manner of Expression in that Remote Part of the World. To these I have added the the figure of the Roman Abacus. Which question less was the Ground of the signification of figures according to places. As also that of the Chinese in the Dictionary of the Court Language, differing from that of Martinius described in the first Decad of his Chinese History, 1st. in that the Dignity of the places here ascend from the Left to the Right; contrary to what he sayes of his: and 2^{ly}. In that this has one bead only for the fifth or 6th. And his hath two;

E R R A T A.

*Page 56 line 22 for about read above. P. 64. l. 23. r.
Obelisks.*

*A Voyage of the Emperour of China into the Eastern
Tartary, Anno. 1682.*

THE Emperour of China made a Voyage into the Eastern Tartary, in the beginning of this Year 1682, after having appeased (by the Death of three Rebellious Kings) a Revolt, formed in some Provinces of the Empire: One of those revolted Princes, was strangled in the Province, of which he had made himself Master: The second being brought to *Pekin*, with the Principal Heads of his Faction, was cut in Pieces in the sight of the whole Court: The most Considerable among the *Mandarines*, acting with their own hands in this sad Execution, to Revenge upon this Rebel the Death of their Parents, which he had caused to be cruelly murdered.

The third which was the most Considerable, (and indeed the Chief of all the Revolt) had by a voluntary Death prevented his deserved Punishment, and so put an end to a War, which had lasted for seven Years.

The Peace having been settled, by the Re-establishing in the Empire and all the Provinces, the Peaceable Enjoyment of their Ancient Liberties: The Emperour departed the 23^d. of March, to go into the Province of *Leaotum*, the Country of his Ancestors, with a Designe of visiting their Sepulchres, and (after having honoured them with the usual Ceremonies) of prosecuting his Journey into the Eastern Tartary: This Journey was about 1100 miles, from *Pekin* to the end of it.

The Emperour took with him his eldest Son, a young Prince of ten years old, which had already been declared Heir of the Empire: The three principal Queens went also in this Journey, each in their gilded Chariot; the principal

pal Kings also which compose this Empire, were accompanying with all the Grandees of the Court: And the most considerable *Mandarines* of all the Orders, who having all a very great Train of Attendants, and very numerous Equipage, made a Court about the Emperour of more then 70000 Persons.

It was his Will that I should accompany him in this Journey, and that I should be always near him, to the end I might make in his Presence, the Observations, necessary for knowing the disposition of the Heavens, the elevation of the Pole, the magnetical Declinations of every Place, and for measuring with Mathematical Instruments, the height of the Mountains, and the distances of Places: He was well pleased also to be informed of what concerned Meteors, and many other Physical and Mathematical Matters.

In so much, that he gave Order to an Officer to carry upon Horses such Instruments as I should have occasion to make use of, and recommended me to the Prince his Uncle, who is also his Father in Law, and the second Person of the State, he is called by a *Chinese* Name, which signifies an Associate of the Empire: He gave Charge to him to cause all things to be provided for me which were necessary for this Journey, which this Prince performed with a very particular goodness, causing me to lodge always in his own Tent, and to eat at his Table.

The Emperour ordered that they should give me Horses of his own Stables, to the end I might the more easily change in riding, and some of those were of them he himself had rid, which is a mark of very extraordinary distinction. In this Journey we always went toward the North-east: From *Pekin* to the Province of *Leao-tum*, the way being about 300 miles is pretty equal: In the Province it self of *Leao-tum*, it is about 400 miles, but much more unequal by reason of the Mountains; from the Frontier of this Province to the City of *Ula*, or the River which the *Tartars* call *Songoro*, and the *Chinoise Sumboa*, the way (which is about 400 miles

miles) is very difficult, being crossed sometimes by Mountains extreamly steep, sometimes by Valleys of extraordinary depth, and through Desert Plains, where in for two or three dayes march we met with nothing. The Mountaines of this Country are covered on the East side with great Oakes and old Forrests which have not been cut for some Ages.

All the Country which is beyond the Province of *Leao-tum* is exceeding desert where nothing is to be seen on all sides but Mountains and Vallys, and Denns of *Bears*, *Tigres* and other *Devouring* beasts, you can scarce find a house, but only some *poor Reed hutts*, upon the sides of some brooks, and streames. All the Citys and *Burrow-towns* which I have seen in the Province of *Leao-tum*, and which are in very great numbers are intirely ruined: One can see nothing through the whole Country but old ruined Walls with Rubbell, Bricks and Stones. In the out skirts of these Citys there have been of late some few houses built, but without any order. Some of them made of Earth, others of the Rubbish of the old Buildings, the most part of them covered with straw or thatch, and but few with tyles. There is now not the least footsteps remaining of a great number of Towns and Villages which were here before the Warr. Because the petty King of the *Tartars*, who began to kindle this Warr having but a very small Army, caused the Inhabitants of those places to take Armes, which places he forthwith destroyed, that he might take from his Soldiers the hopes of ever returning again to their own *Homes*.

The Capital City of *Leao-tum*, which is called *Xin-Yam*, is a City very fair and prety intire, it has as yet the Remaines of an antient *Palace*. It is (for as much as I was able to remark by divers Observations) of the Latitude of 41 degrees 56 *minuts* that is to say, two degrees above *Pekin*, tho' hitherto both the *Europeans* and the *Chinesse* have given that City the Latitude of 41 degrees. There is in that City no declination of the Magnetick Needle, as I have found by many reiterated Observations. The City of

Ula which was almost the very extream of our Journey lyes in 44 degrees and 20 minutes. The compass there declines from the South to the West one degree 40 minutes.

But to Resume the prosecution of our Journey, from *Pekin* to this Extream towards the East there is made a new Way, by which the Emperour can commodiously March with his Horse, and the Queens in their Chariots. This Way is about 10 foot broad, and as even and streight as could possibly be made; it is extended above 1000 miles, it has a little Raifing on each side of about a foot high every where equal and perfectly Parallel to one another; and this Way was as neat especially when the Weather was fair, as a Floor where the Husbandmen beat out their Corn in the Field, there were also certaine Persons along this way, who only took care to smooth and cleanse it. The Christians have nowhere so great care of sweeping their streets and publick Places where the holy Sacrament is to pass in the Processions, as these Infidels have of cleansing the Ways, where their Kings and their Queens are to pass, every time they go out of their Palaces.

There was made for their Return a way like the former, they plained or levelled the Mountains as far as they were able, they raised Bridges over the Rivers, and for ornamenting them, they had extended on each side of them a sort of Matts upon which they had painted divers Figures of Animals, which had the same effect with Tapestry Hangings, with which the Streets are usually hung in Procession.

The Emperor did very seldom make use of this Way, being almost alwayes in Hunting: And when he accompanied the Queens he only Rode by the side of it, to the end that the great number of Horse which were in the Train that followed should not spoile it: He ordinarily marched at the Head of this kind of Army. The Queens followed Immediatly in their Chariots, with their Train and their Equipage; they notwithstanding left some space between the King and themselves: After these marched the Kings, the Grandees of
the

the Court and the *Mandarines*, every one according to his Rank, behind these an infinity of Attendants, and other people on Horse-back brought up the Rere-guard.

As there was not one City upon all this way, that could either lodge so great a Multitude, or furnish them with Provisions, and that the greatest part of their Journey was through a Country very little inhabited, so they were necessitated to carry along with them all things that were necessary for the Journey, and even Provisions of Victuals for three Moneths.

Upon this Account there were sent before by the ways which were made on each side of the Emperours Way, an Infinity of Waggon, Camels, Horses, and Mules for to carry the Baggage: Besides these the Emperour, the Kings and almost all the Grandees of the Court, had great numbers of Horses led, for the use of changing from time to time. I do not here reckon the droves of Beefs, Sheep, and other Cattel, which they were obliged to have with them. And though this great Multitude of Men, Horses, and Drovers, passed by a way at a good distance from that of the Emperour, yet it raised so horrible a dust, that we always seemed to march in a cloud, and thence found it difficult to distinguish those that marched 15 or 20 paces from us.

The March was so well regulated, that this Army incamped every night upon the sides of some River or Brook. 'Twas for this Reason that they caused the Tents and the Baggage necessary for this Incamping to set out very early in the Morning; and the Quarter-masters upon their first arrival, marked the Ground most proper for the placing of the Emperours Tent, of the Queens, of the Kings, of the Grandees, of the Court, of the *Mandarines*, each according to his Dignity, and according to the Dignity he had in the *Chinese* Militia, which is divided into eight orders or into eight Standards.

In the space of three moneths we passed about 1000 miles, advancing towards the North-east, and about as many

In our returne: In fine we arrived at *Kam-Hay*, which is a Fort situated between the South Sea and the Mountaines of the North: It is there where is the beginning of that so much cellebrated Wall, and which seperates the Province of *Leao-tum* from that of *Pekely*; from whence it is extended very farr on the side of the North over the tops of the highest Mountains. When we entred this Province, the Emperour, the Kings, and the Grandees of the Court, quitted the great way of which we have hitherto spoken, to take that of the Mountains of the North, which are extended without interruption towards the North-East: There some dayes were passed in Hunting, which was performed in this manner.

The Emperour chose 3000 men of his Life-guard, armed with Arrows and Javellings, and disperfed them some on this side some on that; so that they posselt themselves of a great circute about the Montains, which they invironed on all parts, which made a kind of Circle whose Diamiter was at least 3000 *paces*; then marching to draw nearer together with equal progresse and without quitting their range, whatever Obstacles they found in way (the Emperour having joyned with them severall of the Captains, and of the Grandees of the Court, for the better keeping of their Order) they Reduced this great Circle to another much less, which had about 300 *paces* in the Diameter: So that all the Beasts which had been stayed within the first, found themselves taken in this last as in a Net: for that every one setting his feet upon the ground, they Locked themselves together so closely, that they left no meshing place for them to make their escape by. Then they Pursued them so Vigerously in this little space, that the poor creatures tired with the violence of their Courfing, came and fell down at the feet of their Chafers, and suffered themselves to be taken without trouble. I saw taken in this manner two or three hundred Hares in less then one day, without counting an Infinite of Wolves and Foxes. I have seen the same thing divers times done

done in that part of *Tartary*, which is on the other side of the Province of *Leao-tum*, where I remember to have seen, amongst others, more than 1000 Deer so perit up by these sort of Netts, which came to cast themselves into the hands of the Hunters, having found no passage to save themselves by: they kill'd also Bears, Bores, and more than 60 Tigres, but these are taken by other meanes, and with other weapons.

The Emperour willd that I should be present at all these different Huntings, and he recommended to his Father in Law, in a most obliging manner the having a particular care of me, and of giving charge that I should not be exposed to any danger in the Hunting of the Tigers, and the other fierce Beasts; I was the only Person of all the *Mandarines* who was without Arms, and so near to the Emperour, though I made light of the Fatigue during the time we were on our Journey, I found my self so wearied every evening when I got to my Tent, that I was not able to support my self; and I should have dispensed with my self divers times from following the Emperour, if my friends had not counsel'd me to the contrary, and if I had not fear'd that he would have taken it ill if he should have perceived it.

After having passed about 400 miles in Huuting daily after this manner, we arrived at last at *Xyn-Tam*, the capital City of the Province, where we stayed four days.

The Inhabitants of *Coree* came to present to the Emperour a *Sea-calf* which they had taken, the Emperour caused me to see it, and asked whither our *European* Books had spoken any thing of this Fish; I told him we had a Book in our Library at *Pekin* which had explain'd the Nature of it, and dispatched presently a Currier to our Fathers at *Pekin*, who brought it me in a few days: The Emperour was pleased to see that what was sayd of this Fish in this Book, was agreeable to this which he had seen, and caused it to be carried back

back again to *Pekin* to be carefully preserved.

During the stay which we made in this City, the Emperor with the Queens went to visit the Sepulchers of his Ancestors, which are not very far distant, from whence he sent them back to *Xyn-Tam*, to continue his own Journey into the Eastern *Tartary*.

After several days of Marching and Hunting, he arrived at *Kirin*, which is distant from *Xyn-Tam* 400 miles : This City is built along the great River *Songoro*, which takes its source from the Mountain *Cham-pe*, distant 400 miles towards the South : This Mountain so famous in the East for having been the Antient Seat of our *Tartars*, is alwayes covered with Snow, from whence it had its Name, because *Cham-pe* signifies the white Mountaine.

So soon as the Emperour saw it, he alighted from his Horse and fell on his knees on the bank of the River, and bowed himself three times to the Ground to Salute it : After which, he caused himself to be carried upon a Glorious Throne of Gold, and so made his entry into the City : All the people ran in a throng before him, testifying by their Acclamations the Joy they had to see him. This Prince took great pleasure in those Testimonies of their Affection; and that he might give them some Marks of his being very sensible of it, he was pleased to suffer himself to be seen by all, and forbid his Guards to hinder the people from approaching him, as they used to do at *Pekin*.

They make in this City Barks of a very particular manner : The Inhabitants keep alwayes a great number of them ready fitted to Repulse the *Muscovites*, who come often into this River, to dispute the fishing of Pearls. The Emperor Reposed himself two dayes, after which he Descended upon the River with some Lords, accompanied with more then 100 Boates, till he arrived at the City of *Ula*, which is the fairest of all this Country, and which at other times hath been the Seat of the Empire of the *Tartars*.

A little below this City, which is at most about 32 miles from

from *Kirin*, the River is very full of a certain fish which resemble near enough the Plaice of *Europe*: and 'twas principally for the taking the Divertisement of Fishing, that the Emperor went to *Ula*; but the Rains coming on so suddainly, swelled the River so much, that all their Nets were broken and carried away, by the great Flood of those land Waters: The Emperor notwithstanding stayed 5 or 6 dayes at *Ula*; but seeing the Rains were not at all discontinued, he was obliged to come back to *Kirin*, without having enjoyed the Pleasure of Fishing: as we ascended the River, the Bark wherein I was with the Emperors Father in Law, was so indammaged by the agitation of the Waves, that we were constrained to go a Shore, and mount a Charriot drawn by one Oxe, which carryed us very slowly to *Kirin*, the Rains not at all ceasing during our Journey.

In the Evening when the Emperor was entertained upon all these Adventures, he said Laughing, *the Fish have cheated us*; at length, after we had stayed two dayes at *Kirin*, the Rains began to Deminish, and we re-took our way towards *Leao-tum*. I cannot here expresse the paines and Fatigues these had caused us to undergo, during the whole course of this Journey, by reason of the ways which the Rains had spoiled, and rendered almost Impossible: we went without staying over the Mountains and over the Vallies, and we could not pass but with extream Danger, the Brooks and Rivers which were swelled by the Floods and Inundations which ran from all parts: the Bridges were either overturn'd by the Violence of the Currents, or all covered by the great overflowing of the Waters. There were made in divers Places great Collections of Water, and of Mudd, that it was almost impossible to be drawn out of it. The Horses, Cammels, and other Beasts of Burthen, which carried the Baggage could not advance, but remained sticking in the Mudd of the Marshes, or Dyed of tiring upon the Ways. The Men were not at all less incommoded, and all were enfeebled for want of Victuals, and of Re-

freshments necessary for so great a Journey: Many of the Horsemen were obliged, either to lead their Horses on Foot, who were no longer able to carry them, or to rest in the middle of the Fields to suffer them to take Breath: And though the Quarter-masters and the Harbingers, spared not their Pains, nor for Wood (which they cut on all sides) to fill with Faggots all the bad Passages: Yet notwithstanding after the Horses and Chariots, which took the Van early in the morning had quite passed, it was Impossible to pass after them: The Emperor himself, with his Son, and all the great Lords of the Court, were obliged more than once, to foot it over the Mud and the Marshes, fearing to expose themselves to greater danger, if they should have passed them on Horse-back.

When they came to Bridges, or those other obstructions all the Army stayed: And as soon as the Emperor was passed, with some of the most considerable Persons, all the rest came together in a Throng, and every one striving to pass first, many were tumbled over into the Water: Others taking ways more about, found them more Dangerous, falling into Sloughs and Bogs, out of which they could not Recover themselves. In fine, there were so many Inconveniencies to be met with, in all the Ways of Eastern *Tartary*, that the old Officers who had followed the Court above 30 years, said they had never suffered so much in any Journey.

It was on those Occasions, that the Emperor more than once, gave me the Marks of a Respect altogether particular: the first day that we put our selves in the way for returning, we were stayed in the evening, by a Torrent so great and Rapid, that 'twas impossible to Ford it: The Emperor having by chance found a little Boat, which could not hold above 4 Persons at most, passed first with his Sons, and some of the Principal Kings followed: All the other Princes, Lords, and *Mandarines*, which the rest of the Army attended, (in the mean while) with Impatience the return of the Boate, to carry them to the other side of the Torrent, because the night ap-
proch-

proched, and the Tents had long before passed: But the Emperor being come back to us in such another Boat as the former, demanded aloud where I was; and his Father in Law having presented me to him, he added, let him come in and Cross over with us: So we were the only persons that passed with the Emperor; and all the rest staid on the Bank, where they must pass the night *under the open Heaven*: The same thing hapned the next day almost in the same manner. The Emperor at Noon meeting with a like Rapid andswelled Torrent, gave order that the Boats should be made use of for Transporting the Tents, Packs, and other Baggage till the Evening, then willed that I should pass alone with him and some few of his Attendants, having left on the other side all the Great Lords, who were necessitated to pass the Night there: The Emperors Father in Law himself, having asked if he should not pass with me, since I lodged in his Tent and eat at his Table; this Prince answered him, that he should stay, and he himself would take Order to give me what was necessary.

After we had past, the Emperor sitting on the Bank-side, made me sit by him, with the two Sons of the two Petty Western Kings, and the first *Colao* of *Tartary*, whome he distinguished on all Occations.

As the night was fair, and the Heavens very cleer; he willed me to Name in the *Chinese* and *European* Languages, all the Constellations that then appeared above the Horizon, and he himself first named all those he already knew; then unfolding a small Map of the Heavens, which I had some years since presented him, he put himself upon inquiring the Hour of the Night, by the Stars in the Meridian: Pleasing himself to shew to all, the Knowledge he had acquired in these Sciences. All the Marks of his Favours which he so often gave me, even to the sending me to eat from his own Table; these marks I say were so Publick, and so Extraordinary; that the two Uncles of the Emperor, who bore the Titles of Associates of the Empire, being on their return to

Pekin, said that when the Emperor had some Regret or appeared somewhat Sad, he would Resume his ordinary Gallie upon the sight of me.

I arrived at *Pekin* in perfect Health the 9th day of June very late, though divers were detained in the way by Distempers, or were returned from their Journey, Hurt and Lamed.

I say nothing of what we did for Religion in this Journey, having Reserved that for a particular Relation, by which it will appear, that by the Grace of our Lord, the Favours we received at the Court of *China*, produced considerable Fruits for the Church, and did not take away the Cross from the Missionaries.

I shall here add the *Tartarean* Names, and the distance of every Place through which we passed in the Eastern *Tartary*, from the Capital of the Province of *Leao-tum* even to *Kirin*, according to the order of Days which we spent in this Progress. A *Topographick Chart* may be made and inserted into the Map of the Province of *Leao-tum*, to be found in the Atlas of Father *Martin Martinius*, by changing only the *Latitudes* according to the heights of the *Pole*, which we have before Specified.

I shall add one thing more which I Understood from the Inhabitants of *Ula*, to wit that *Nincrita* (which is a Place much Renowned in those Parts) is distant from *Ula* 700 *Chinese Stadia* (each of which is 360 *Geometrical Paces*) And that Imbarking at *Nincrita* upon the great River *Helum*, into which the *Songoro*, and some other more considerable Rivers are discharged, and following the course of the River, which runs towards the North-East, or somewhat more to the North, they arrive in 40 dayes Journey at the Eastern Sea, which is (as I beleive) the Streight of *Anien*: I was told this by the General of the Militia which is at *Kirin*, and who had performed this Voyage himself.

*The Distances of the Places, through which we passed
in the Eastern Tartary.*

THe first Day we passed from *Xyn-Tam*, the Capital of the Province of *Leao-tum*, and we arrived at *Seac-Lysto*, so the place is called in the Chinese Language. ————— 95. *stadia*.

The 2d. day we arrived at *Cha-cay Angha*. ————— 85. *stadia*.

The 3d. day at another Torrent ————— } — 70. *stadia*.
of the same Name. ————— }

The 4th. at *Kiaghuchen*. ————— 50. *stadia*.

The 5th. at *Feyteri*. ————— 80. *stadia*.

The 6th. at the Torrent of *Scipery*. ————— 60. *stadia*.

The 7th. at the Torrent of *Ciam*. ————— 60. *stadia*.

The 8th. at *Courou*. ————— 50. *stadia*.

The 9th. at the Burrow of *Sape*. ————— 40. *stadia*.

The 10th. at *Quaranny Pyra*. ————— 40. *stadia*.

The 11th. at *Elten eme Ambayaga*. ————— 70. *stadia*.

The 12th. at *Tpatan*. ————— 58. *stadia*.

The 13th. at *Suayen ny Pyra*. ————— 60. *stadia*.

The 14th. at *Ilmen*. ————— 70. *stadia*.

The 15th. at *Seuten*. ————— 70. *stadia*.

The 16th. at the City of *Kirin*. ————— 70. *stadia*.

1028.

All this Course being 1028 Chinese Stadia, contains 369 miles (each) of 1000 Geometrical Paces; the Chinese Stadium containing as I mentioned before 360 Geometrical Paces.

*A Voyage of the Emperor of China, into the Western
Tartary, in the Year, 1683.*

THe Emperor this Year, which is the 30th. of his Age, made a Voyage into the western *Tartary*, together with the Queen his Grand-mother, which they call the *Queen Mother*, he departed the 16. of *July*, in the Company of more than 60000 Men, and 100000 Horse. He positively resolved, that I, with one of the two Fathers that were at the Court of *Pekin*, the Choise of which he left to me, should follow him. I chose Father *Philip Grimaldi*; because he is the most known, and because he perfectly understood the *Mathematicks*.

Several Reasons prevailed with the Emperor to Enterprize this Journy. The first was, that he might keep his Militia during the Peace as well as in the Warrs, in continual Exercise; and for this Reason it was, that after he had establish't a firm Peace in all the Quarters of this so vast an Empire; he recalled his best Troops hither out of every Province, and resolved in his Council to make every Year Expeditions of this kind, in several Seasons, that by hunting of Deer, Bores, Bears, and Tigres, they might learn to overcome the Enemys of the Empire, or at least to prevent the cooling of their Courage, or the degenerating from their Pristine Valour, by the Luxury of *China*, in a too long Repose.

In effect these kinds of Hunting had more of the shew of a Military Expedition, then of one for Divertisement, as I have already noted; The Emperor took in his Train, 100000 Horse, and above 60000 Men, all armed with Arrows and Ciiniters, divided into Companys and March-
ing

ing in Battell-Array after their Colours, with the sound of Drums and Trumpets: During their Hunting, they intirely invested the Mountains and Forrests, as if they had been Cities which they designed to Beleaguer; following in this, the manner of Hunting used by the eastern *Tartars*, of which I have spoken in my last Letter. This Army had its Vanguard and Rere-guard, and its Main Body, its Right Wing and left Wing, was commanded by so many Generals and petty Kings. There were spent more then Seventy days before they were on their March, in bringing together all the Ammunitions of the Army upon the Waggon, upon the Camels, upon the Horses, and upon the Mules, by reason of the Incommodious Ways. For in all the western *Tartary* (I call it western) not with relation to *China*, which Lyeth in Respect of it westward it self, but with respect of the Eastern *Tartary*) there is nothing to be found but Mountains, Rocks, and Vallies, there are neither Cities, Towns, nor Villages, nor so much as any Houses. The Inhabitants Lodge under Tents, pitched on all sides in the open Feilds. They are for the most part Grasiers, and transport their Tents from one Vally to another, according as the Pastures are better. There they Pasture their Beefs, their Horses, and their Camels, they breed no Hoggs, nor any of those other Animals, which else where are fed in the Villages, as Poultry and Geese. But only of such as the Herbs, which an uncultivated Land doth Naturally produce, will serve to sustain. They pass their Life either in Hunting, or doing nothing. And as they neither Sow nor cultivate the Earth, so they make no Harvest. They Live upon Milk, Cheese, and Flesh, and have a sort of Wine, not much unlike our Aqua-vitæ; with which they make their Feasts, and are often Drunk. In short they care for nought from Morning to Night, but to Drink and Eat; like the Beasts, and Doves which they Feed.

They are not without their Preists, which they call *Lamas*, for whome they have a singular Veneration, in which they differ from the Oriental *Tartars*; the most part of
whome

whome have no Religion, nor do they beleive any God. For the rest both of the one and the other are Slaves, and wholly depend upon the will of their Masters, whose Religion and Manners they Blindly follow: Like in this to their Doves, who go where they are Lead, and not where they ought to go.

This part of *Tartary*, Lyes without the Prodigious Wall of *China* about 1000 *Chinese Stadia*, that is to say more than 300 *European Miles*, and extends from the North-east towards the north.

The Emperor Rides on Horse-back, in the Head of his Army through these Desert Places, & these Steep Mountains, and far from great Roads, exposed all the day to the Scorplings of the Sun, to the Rains, and to all the Injuries of the Air. Many of those which had been in the last Warr, assured me, that they had not suffered so much during all that, as during this Hunting. In so much that the Emperor, whose principal Aim it was, to give his Forces a Breathing, performed effectually what he pretended.

The second Reason he had of undertaking this Journey, was that he might keep the western *Tartars* in their Duty, and to Prevent any pernicious Designs, that might be formed against the States.

It was for this that he entred their Country with so great an Army, and with so great Preparations for Warr. Having carryed along several great Gunns, that he might cause them to be Discharged from time to time into the Vallies, and by the Noyse and Fire which issued out of the Mouths of those Dragons, which served to ornament them, he might cast a Dread upon the Rout.

Besides this great Retinue, he would yet be accompanied with all the Marks of Grandure, with which he was invironed at the Court at *Pekin*. To wit, with a Multitude of Drums, Trumpets, Timbals, and other Musical Instruments, which formed Conforts During his sitting at Table, when he entred the Pallace, or when he went out. He caused all these

these to march with him, that he might by this outward Pomp Astonish these *Barbarous* People, to stricke them with a Fear and Respect of his *Imperial Majesty*.

For the Empire of *China* never had any Enemies more to be feared than these *Western Tartars*; which beginning on the east of *China* incompass it with an almost Infinite of people, and keep it as it were continually beleagured on the North and West sides thereof; and 'twas to make a Bulwork against their Incursions, that a *Chinese* Emperor in Antient times caused this great Wall to be Built, which seperates *China* from their Countrey. I have passed it fower times, and have considered it very attentively. And I can say without Hyperbolizing, that all the seven Wonders of the World put together, are not comparable to this worke. And all that *Fame* has spred concerning it among the *Europeans*, is far short of what I my self have seen.

Two things have more especially canfed my Admiration. The first is, that in this long extent from the East to the West, it passes in several places not only through vast champanes, but also above the tops of exceeding high Mountains, upon which it is raised by little, & little, and Fortified at certaine Intervales with great Towers; not distant the one from the other more then two flight shot. At our return I had the curiosity to measure the hight of it in one place by meanes of an Instrument, and I found that it was in that place 1037 *Geometrical feet* above the Horizon; in such sort that 'tis hard to comprehend how 'twas possible to Elevate this Enormous Bulwork to the hight we saw it, in places dry and full of Mountains, whence they must be obleiged to bring from a great distance with Incredible Labour, the Water, Brick, Morter, and all the Materials necessary for so great a Work.

The second thing that Surprised me was that this Wall is not continued upon the same Line, but bent in divers places following the Situation of the Mountains, in such manner that instead of one Wall, one may say that there are

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three,

three, which Inviron all this great Part of *China*.

After all, The Monarch which in our Dayes hath Re-united the *Chinefe* and the *Tartars*, under one and the same Government, has done some things more for the advantage of the Security of *China*, than the *Chinefe* Emperor that Built the long Wall. For after having Reduced the Western *Tartars*, partly by Artifice, partly by Force of Armes: He has Obleiged them to go and remaine at 300 *Miles* Distance from the Wall of *China*; and in this place he Distributs to them Lands and Pastures, whilst he has given their Conuntry to other *Tartars*, his Subjects which have their Habitation there at present: Notwithstanding which these Western *Tartars* are so Powerful, that if they should agree together, they might make themselves Masters of all *China*, and of the Eastern *Tartary*, Even in the face of the Oriental *Tartars*.

I have said, that the *Tartarian* Monarch that Conquered *China*, used an expedient for Subduing the Western *Tartars*. For one of his first Cares was to engage to his Interest by his Royal Bounties, and by Demonstration of a Singular Affection, the *Lamas* (or *Preists*) these Men having a great Repute about all those of their Nation, easily perswaded them to Submit to the Government of so great a Prince, and 'tis in consideration of this Service done to the Estate, that the present Emperor looks upon these *Lamas* with a Favourable Eye, that he bestows Presents on them; and that he makes use of them to keep the *Tartars* in the Obedience which they owe him: Tho' at the Botom he hath nothing but Dis-esteem for their Persons, and looks upon them as a Sort of Ignorant Fellows, which have not the least Tincture of the Sciences or Commendable Arts, in which without doubt this Prince shews a Wise Policy, in so Disguiseing his true Sentiments, by these Exterieur Marks of Esteem and Goodwil.

He has Divided this Vastly extended Country into 48 *Provinces*, who have Submitted and are Tributary to him.

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From whence it comes to pass, that the Emperor that Reigns at present in *China*, and in the one and the other *Tartary*, may justly be called the Greatest and most Powerful Monark of *Asia*, having so many vast Estates under him, without being any where interrupted by the Territory of any Forrein Prince, and he alone being as the Soule which gives Motion to all the Members of so vast a Body.

For after he had charged himself with the Government, he did not at all intrust the Care to any of the *Colaos*, nor to any of the great Men of his Court. He has not at all suffered, that the *Evnucks* of the Palace, or any of his Pages, or any of the young Lords that have been Raised by him, should dispose of the least thing in his House, or should Regulate any thing of themselves: which appears very extraordinary; especially if we examine what Customes his Predicessors were wont to use.

He Chastises with wonderful Equity the Great Ones as well as the Inferiors; he Deprives them of their Charges, and makes them descend from the Rank they held, Proportioning always the Penalty to the Heinousness of their Fault. He takes Cognisance of the Affairs which are transacted in the Royal Council, and in the other Tribunals, even to the causing them to Render to him, an exact account of the Judgments there given. In one word, he of himself Disposes and Orders all things; and 'tis by reason of the Absolute Authority which he hath thus acquired, that the greatest Lords of the Court, and Persons of the highest Quality in the Empire; even the Princes of the Blood, never appear in his Presence, but with a Profound Respect.

But to what remains, the *Lamas* or *Tartarian* Priests, of whome we have spoken, are not only respected by the People, but also by the Lords and Princes of their Nation, who for Politick Ends testify to them a great deale of Freindship: This makes us fear that the Christian Religion, will not find so easy an Entrance into the Western *Tartary*. They are also very powerful upon the Mind of the Queen

Mother, who is of their Country, and who is at Present Threescore and Ten Years Old ; they are wont to tell her, that the Sect (of which she makes Profession) has no more declared Enemy then us. And 'tis a kind of Miracle, or at least an extraordinary Protection of God, that notwithstanding this, the Emperor, who has very much Regard and Respect for her, has not hitherto ceased to heap on us Graces and Honours, considering us after an other manner than the *Lamas*.

During the Journey, as the Princes and the cheif Officers of the Army went often times to the Queen to attend at her Court ; and that we also were advertised to do so likewise : We were willing first to consult a Person of the Court, who loved us vry much, and who spake for us to the Emperor in our Affairs. This Lord having entered the Princes Tent, told him what had passed, and presently coming out again : *The Emperor* (said he to us) *has given me to understand, that 'tis not at all necessary for you to attend the Queen as others do ;* which made us to apprehend enough, that this Princess did not Favour us.

The 3^d. Reason which the Emperor had for making this Journey, was for his Health : because he knew by Experience long enough, that when he is too long at *Pekin* without going abroad, he cannot avoid his being attacked by several Distempers, which he prevents by means of these long Progresses. For during the whole time he never sees any Woman ; and that which is more surprising, there appears not any one in all this Great Army , except those which are of the Retinue of the Queen Mother : 'Tis yet also a Novelty that she has accompanied the King this Year, it having not been practised above once, when he took with him the three Queens as far as the Capital City of the Province of *Leaotum*, to visit the Sepulchres of their Ancestors.

The Emperor and the Queen Mother pretend moreover by this Journey, to avoid the excessive Heats which are in

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Pekin, in the Summer during the Dog-days. For in this Part of *Tartary*, there Reigns during the Moneths of *July* and *August* so cold a Wind, especially in the Night, that 'tis necessary to put on thick Cloths and Furrs. The Reason that may be assigned for this so extraordinary Cold, is that this Region is very much elevated and full of Mountains. There is one amongst the rest, upon which we continually ascended for the Space of 5 or 6 Dayes March. The Emperor being desirous to know, how much it surmounted the Plains of *Pekin*, Distant about 300 Miles; at our Return (after having measured the Height of above a Hundred Mountains that lay in our Road) we found that it had 3000 Geometrical Paces of Elevation, above the Sea that nearest approached *Pekin*.

The Salt Peter also with which these Countrys abound, may contribute to this great Cold, which is so Violent, that in Digging the Earth to 3 or 4 foot deep, there are fetched out Clods all Frozen and peices of Ice.

Divers of the Petty Kings of the Western *Tartary*, came from all Sides for 300 Miles, and some for 500 Miles, together with their Children, to Salute the Emperor. These Princes, who for the most part know none but their own Natural Language, which is very different from that of the Eastern *Tartary*: took Regard of us, with Aspects and Gestures of a Goodness very particular. There were some amongst them, who had made a Journey to *Pekin* to see the Court, and who had seen our Church.

One or two days before we arrived at the Mountain which was the boundary of our Journey, we met a Petty King very aged, who returned from accompanying the Emperor, he seeing us stayed with all his Retinue, and enquired by his Interpreter, which of us was called *Nauboaïj*, one of our Servants having made a Signe that it was I; this Prince accosted me with a great deal of Civility, and told me that for a long time he had known my Name, and that he had desired to know me. He spoke also to Father *Grimaldi*,
with

with the same Marks of Affection. The favourable Entertainment he gave us in this Rancounter, gave some Reason to hope that our Religion might find an easy Entrance to those Princes, particularly if care be taken to insinuate into the Minds of those Princes, by the Means of the Mathematicks: Which if there should at any time be a Designe to penetrate into their County: The most sure way for divers Reasons, (which I have not the Leisure to Explain here) will be to begin the Entrance with the other *Tartars* more Remote, which are not at all Subjects of this Empire, from whom we may pass on to these, advancing by little and little towards *China*.

During the whole Journey, the Emperor has continued to give us singular Tokens of his Good Will, shewing us Favours in the Sight of his Army, which he shewed to none besides.

One time meeting us in a great Vally, where we were measuring the height and the distance of some Mountains, he made a Stay with the whole Court, and calling to us from a great distance, he demanded of us in the *Chinese* Language, *Hao-mo*? that is to say, are you well in Health? And then asked us several Questions in the *Tartarean* Language, concerning the height of these Mountains, to which I answered also in the same Language; after which turning to the Lords that were about him, he discoursed with them concerning us in very obliging Expressions, as I learned the same Night from the Prince his Uncle, who was then by his side.

He testified also his Affection to us, by causing often meat to be carryed to our Tents from his own Table, willing also that on some Occasions we should eat in his; and every time he did us this Honour, he had a Regard to our Days of Abstinence, and of Fasting, sending us only such Meats as we could use.

The eldest Son of the Emperor after the Example of his Father, gave us Marks also of his Bounty, for having been con-

constrained to stay more then 10 days, by reason of a Fall from his Horse, by which he was hurt in his right Shoulder; and one part of the Army in which we were, having attended, whilst the Emperor with the other continued his Hunting, he was not wanting in sending to us daily, and sometimes twice a day during this space, Food from his own Table. In fine, we lookt on all these Favours of the Royal Family, as the Effects of a particular Providence which watched over us, and over Christianity, for which we had so much the more occasion to thank God, for that the Affection of the Emperor, was never so constantly shewn to the Grandees of the Empire, nor to the Princes of the Blood.

As to what relates to the other Particularities of our Journey, they are like to those which happened to us the last Year, in the Journey to the Eastern *Tartary*, which I have fully described in my last Letter; that is to say, that we made use of the Emperors Horses, and of his Litters, that we lodged in the Tents, and eat at the Table of the Prince his Uncle, to whome he had particularly recommended us.

During more than 600 miles, which we had passed in going and returning (for we did not return by the same Road) he caused to be made a great High-way cross the Mountains and the Vallies, for the Queen Mother, who went in a Charriot; he caused also an infinite of Bridges to be made over the Torrents, as also the Rocks to be cut, and the Points of the Mountains, with incredible Pains and Expences: Father *Grimaldi* shall describe the other particulars in his Letter.

As to the benefit which the Religion may draw from our Journey, I have spoken elsewhere; it sufficeth to say that the Emperor, to whose Will we cannot make the least resistance, without exposing all this mission to a manifest Danger, has ordered us to follow him. I ceased not however to speak twice to that Lord of the Court, who is our
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particular Friend, to excuse us for the time to come, from these long Journies, and especially me, who am not of an Age fit for it : I tryed to obtain at least that they would be contented to take only one of us ; the Letters of our Fathers were daily brought us during the Journy, and I had the convenience of writing to them, by means of the Curriers which continually went to and came from the Royal City : I write all this in hast, that I may continue to give you an Account of our Affairs.

An Explanation, necessary to justify the Geography supposed in these Letters.

IT may seem wonderful, that the Author of these Letters makes mention in his former, of a kind of Warr between the *Oriental Tartars* and the *Moscovites*, notwithstanding the extream distance, these People appear to be from one another in our Geographical Charts; but those who know how much the *Moscovites* have extended the Bounds of the *Empire* along the *Tartarian* Sea, will judge the thing less difficult, besides those who have seen these Countrys, have made Discoveries much differing from those which our Geographers have informed us of hitherto. Very lately *Monseieur D' Arcy*, who comahds one of the Kings Ships, in the Fleet of *Monseieur Le Marechal d Estrees*, informed us, that having served in *Poland*, and having been made Governor of a Place towards *Moscovy*, the *Moscovite* Ambassadors in their returne having passed by him, and being by him, treated in such a manner as put them into a very good Humor; one of them shewed him a Chart of the Countrys between *Moscovy* and *China* : and told him, that from 3 Citys which he shewed him, whose Names were *Lopsla*, *Abasinko*, *Nerginsko*, all 3 under the Government of the great Dukes, tho' Situated in the great *Tartary*, there was a Way to *Pekin*, which

which was not more than 25 or 30 dayes Journy. This Map it seems must be kept very Secret in *Muscovy*: for the next day the *Muscovite* was in dispair, for having given it, saying that if it should be known he should come to great Dammage. The Officer being come back since into *France*, has given a Copy to the King, and another to *Monsieur Le Marquis de Seignelay*. To confirme this it may be added, what a *French* Man has writ from *Muscovy* within this two Monthes, that they are actually Raifing Troops, to go to War with the *Chinesc*.

Some Observations, and Conjectures Concerning the Chinese Characters. Made by R. H. R. S. S.

Whether there ever were any Language Natural, I dispute not: But that there have been, are and may be artificial Languages 'tis nor difficult to prove. The *Chinese* Court Language is said to be of this kind, invented and Spoken by the *Literati* and *Mandarins* throughout the whole Empire of *China*, differing from all the other Languages spoken in it, and I conjecture it to be nothing els but the names of the Characters by which they write and express their meaning, Arbitrarily Imposed by them, as we in *Europe* set names to Arithmetical Figures, not as we pronounce words written with a Literal Character. This I Judge by comparing the Characters with the Names, Monosyllables or Words they Pronounce and Read them with. Nor do they ascend above a Monosyllabical Name tho' the Character be composed of many single Characters, each of which hath its proper Sense and Monosyllabical Name, And though the meaning of each Character, be an ingredient in the Notion of that compounded Character.

I might give an instance also in the Artificial Language,
 I might give an instance also in the Artificial Language, In

invented by the Late Reverend Bishop of *Chester*. *Dr. Wilkins*, which in all the accomplishments of Language doth excel any one yet extant ; to which is also annexed a real Character, Legible into that or any other Language Spoken. By which Language the Character and every additional Mark is effable, and yet the Character is not Litteral but Real, which is more curious and useful than the *Chinese* way. Great pitty it is that Discourse is not published in *Latine*, that the Learned of *Europe*, may think of further Improveing it, and bringing it to Use.

But whatever we may judge of Language, tis past dispute that Writing was ever Artificial, how Antiently so ever it were in Use, and was the Invention of some thinking and Studious Men. Tis also evident that there have been various ways thought of for Expressing Significancy, according to the several *Genii* of the Persons that were the Inventors. As may be ghesed by the *Aegyptian* Hieroglyphicks, the *Chinese* Characters, the *Mexican* Chronology, and the Literal Characters of several Nations, each of which seem to proceed upon differing methods. and from differing thoughts of Invention.

Which of these ways is the most Antient, is hard to Prove. The *Aegyptian* *Mummys* and *Obleisks* prove a great Antiquity of the Hieroglyphicks, but yet the *Chinese* Chronology (if to be credited) outstrips the *Aegyptian* in pretence to Antiquity. For the *Chinese* make *Fohi* the first King of *China* to be the Inventer of their Character: And account him to have Lived 2950 *Years* before the time of *Christ*, dureing all which time they pretend to have a certaine and written account in their Books: But their account of the times preceding, they esteem more Hypothetical and Fabulous ; depending cheifly upon Fiction and Oral Tradition: As you will easily beleive, when you understand how many years they make it since the Creation of the World to the present year 1686. which by the account thereof in *Mr. Graves* his translation of *Vlug. Beig.* will be found to be no less then eighty eight millions six hundred and fourty thousand one

one hundred and two Solar Years, there having been run out since the Creation 8864 *Ven.* of Years (every *Ven.* containing ten thousand such Years) and of the present *Ven.* this Year 1686 is the 102d. Which account is abundantly more extravagant than the *Aegyptian*: But this need not Invalidate their History since *Fohi*; by which it appears that their Character was Invented before the time of *Moses* about 1400 Years, and even before *Menes* the first King of *Aegypt* about 500 Years. So that the *Chinese* Invention of Writing or Characters, seems to be the most Antient of that kind. And the Book *Yekim* said to be written by *Fohi*, the most Antient Book.

These accounts made me the more desirous to understand somewhat of the Reallity and Truth, of what is related concerning the Knowledge of Literature and Manual Arts, which these people of *China* are said to have possessed so long a time in so great Perfection, and without Alteration from the Primitive Institution, especially upon the account of their Art of Printing, which gave a hint to the Inventors of that admirable and most useful of all Inventions (for the Common Wealth of Learning) the way of Printing here in *Europe*. For *Paulus Jovius* affirms that the first Occasion of that Invention in *Germany*, was a *Germane* Merchant, who returning out of *China* into his own Country, Related what he had observed concerning the Practise of it as used in that Country. And tho' the *Chinese* way, be wholly differing as to the method of composing, from what was Invented and Perfected here: Yet such an intimation was enough to an Ingenious Artist to improve the first Contrivance, and make it more accomodate to the Literal way of Writing with us: And as our way may possibly be now brought to the greatest Perfection for exactness and expedition, so without doubt must be their way of Printing any thing just as it is written, Since I find, that they can Ingrave their Stamps for a sheet, as soon as one of our Composers can set and correct a sheet of our Literal Character, and when so

done one Man alone will print off 1500 Sheets in one day. And though tis generally believed to be much the same with our *Wooden Cuts* for Printing, yet from some Observations I have made, I believe it to be much another way ; of which I shall hereafter say more when I describe their other Arts of Pottery, Staining, Vernishing, &c.

By a *Chinese* Manuscript, out of which I transcribed the Lords Prayer in the Year 1666 (when it was lost) I found that the Pronuntiatiions had no Affinity with the strokes of the Character. Whence I conceived it was either a numeral Character consisting of Numbers, or else a real Character, but not a Literal, unless it were a Litteral Character of some other Language than that by which it was Pronounced, whose pronountiation is lost though the Significancy be retained, as if one should Read what is written in *Hebrew* ~~ברא~~

ברא into the *Latine* or *Roman* Language, *In Principio Creavit* instead of *Brasit bra.* or *Beresith Bara* according to the *Masoretha*.

Since that time I procured from *China* a Dictionary of the Court Language, (as I found it written upon by the person that sent it me from thence) But this whole Book (which I found was Printed) consisted only of the *Chinese* Characters without any interpretation, or Pronuntiatiion, however by the help of the picturs of that, and a *Chinese* Almanack, I quickly found out their Characters for numbers and their way of Numeration, together with the Figure and use of their *Abacus* or counting Board, for performing the Operations of *Arithmetick*, which I find pretty near to agree with that of the *Antient Romans* (A Description and Picture of which is given by *Ursinus*, *Pignorius* and *Velferus*) save only that, instead of pinns and sliding Groves of the *Romane*, the *Chinese Abacus* hath Strings or Wires and Beads, to slide upon them ; and that, instead of four pinns for Digits or Unites, the *Chinese* hath 5 beades : So that it may seem to argue that the *Chinese abacus* was designed for a *Duodecimal* Progression : Whereas that of the *Romans* was designed for the *Decimal*.

One thing is remarkable in the *Chinese*, that I find the places in the *abacus* to lie *horizontall*, and their first place to be that next the left hand, which I judge was also the first in their old way of reading, much the same with ours, though their other Characters are erected (as I shall by and by shew) from the posture of Writing and Reading, which I conjecture they did at first make use of, and what does yet further agree with this conjecture, is Remarkable in the newly mentioned Treatise of *Vlug Beig*. That whereas the way of Writing and Reading used by the *Arabs*, was from the right to the left, the first place or the place of Units in their Numeration, was that next the right Hand; and so came first to be read: as did that of *China*, who as I conceive read the contrary way, from the left to the right.

It appears therefore by this remark that we received this way of expressing Numbers from the *Arabians*, for that we keep the same posture or position of places with them, though our progression in Writing and Reading be the contrary way. And though we now Read them also in the order they are set, twenty one, twenty two, thirty six, forty eight, &c. yet we retain also the other way of Pronouncing, *viz*, one and twenty, two and twenty, six and thirty, eight and forty, &c.

Now as the *Chinese* and *Roman Abacus* do much agree save only that they proceed contrary ways, so doth their way of expressing Numbers by Letters or Marks, one stroke or line signifying one, two lines, two, three lines, three, a cross ten, two crosses, twenty, three crosses thirty, and so onwards to a hundred, which they expressed by a square mark, and a cross with a stroke added for a thousand, as will appear by the Table annexed. And though the Characters are not all the same; yet the order & method of one agrees very near with that of the other, especially if I may be allowed my supposition, that the Primitive way of Writing and Reading with the *Chinese* was Horizontal, and like the *Greek* and *Latine* or *European* way. Now that these are properly

perly numeral Figures or Characters, is manifest from this, that they have also word Characters for every Number, And they can (in the same manner as the *Romans* could) express a Number by their numeral Characters or Marks, and by their Litteral or word Characters; for as one single stroke signifies one or the first, so does the Character (in the plate marked with E) signify the same thing, that is one or the first.

Having thus discovered their Characters for Numbers, and their way of Numeration, I was next desirous to understand something concerning their Language and Character.

Upon Perusing all the Accounts I could meet with in Books, I found very little satisfaction as to what I principally inquired after, which was first concerning the Method of the Character, whether it consisted of a certain Number of Marks Methodically disposed like Letters in a Literal, or like Numbers in a Numeral or like Radicals in Composite & Decomposite Derivations? 'tis said to be Legible into a great many Languages considerably different one from another, but how this is effected is not related, only 'tis said that the marks are of the Nature of our Arithmetical Figures, (which are become almost Universal at least to us here in *Europe*,) and secondly, concerning the Number of these Characters? to which I found as little satisfaction, for, by some Relations I found that there were 120000, by others 80000 and by others 60000. And that a man must be able to remember to Write and Read at least 8000, or 10000, before he will be able to express his meaning thereby, & that it is the business of a Mans whole Life to be thoroughly understanding in the whole Character; seeming to intimate that the Characters are Immethodical, and there are as many Primitive Characters as Words. Others tell us of various kinds of Characters which have been in use in several Ages. The first they say were *Hieroglyphical* like the *Egyptian* or *Mexican* consisting of the Pictures of Animals & Vegetables. But that the last are made up of Lines & Points, that they have no such thing as Letters or Sylla-

Syllables, but every distinct word & notion has a distinct Character, & that all are primitive or in composuit, So that if *Calepines* Dictionary were to be translated into the *Chinese*, 'twere necessary to have as many distinct Radical Characters as there are words therein to be found. which accounts do seem to inſinuate that this Character is the moſt Difficult, & the moſt perplexed peice of Learning in the World, & depends wholly upon the ſtrength of the memory in retaining the form & ſignification of a perplexed ſcraul. But whether they who gave us theſe accounts did do it knowingly, is much to be doubted, my own obſervations, at leaſt, make me think otherwiſe.

I have not yet been able to procure ſufficient helps to Inform my ſelf of the whole Art of Writing and Reading the *Chinese* Character, and I fear the Relations I have hitherto met with concerning it, were written by ſuch as did not well underſtand it, however from ſuch helps as I had, what I collected or do conjecture, I ſhall here relate. The beſt help I had, was the Peruſal of ſome Books Printed in *China*, with the Pronuntiation and Signification of the Character in Latine Letters. By theſe Books then I obſerved, Firſt, that every one of their Characters whether conſiſting of more or fewer ſtrokes or marks, were comprized within a certain ſquare ſpace, which is proportion'd according to the bigneſs of the ſize or manner of Writing, they deſigne there to make uſe of, not that the whole Square is filled with every Character, but that no part of that Character does exceed the Limits of that Square, ſo that though the Character have but one ſtroak it takes as much room in the line as another that hath 20 or 30 ſeveral marks, ſo that their Characters are moſt exactly ranged in Rank and File, not unlike our Numbers in Arithmatick.

Notwithſtanding, which I find they do vary the bigneſs of the Character upon ſeveral Occaſions, as in the Titles of Books, in the Titles of the Chapters or Sections, in the Comments Explications or Notes, and upon ſeveral other occaſions of Variety, which they do at Pleaſure with their Pencil, as we uſe variety of Letters in the Printing of a Book. The
Titles

Titles of Books are generally in very large Characters, 6 or 8 times as big as those of the Book, the Explication notes ; of the bigness, the contents usually twice as big, and the like variety on several other occasions. I have met with also three several kinds of Characters, the most usual is the fixed or set square form. The second sort is the Running hand in which the orders of the Courts are written by their Secretaries, of which I have seen 3 or 4 kinds, in which the Pencil is never taken off till the whole Character be Finished, and sometimes 2 or 3 are all written without break. The third seems to be some what like the flourishing great Letters used by Scriveners at the beginning of Deeds, and by the *German*s in the beginning of Chapters and Sections. They are compounded of the same strokes as the set Character, but modulated and shaped a little otherwise to make them appear the more beautiful & regular. A Specimen of each of these three are in the plate. This third is made use of for Epitaphs and other Inscriptims on Buildings or Monuments. These 3 sorts I may call the three general kinds of writing, but there is to be found an almost infinite variety of forms, which men use. This will be the more easie to be believed, when we consider that the Printed Characters are exactly the same with the written. insomuch that every variety in each stroke, line or point, that is or can be made with the Pencil, is perfectly expressed in the Impression, and the forme mode, or hand, as we call it of every Writer is exhibited so curiously, that I think it hardly possible to be performed after the way of wooden Cutts as Authors affirm it is, but must be done after the Method of our Copper cutts, printed by a Roule-press, which the way of expressing the Running or Court-hand, does, I conceive most evidently demonstrate, and from divers Circumstances, I could evidently make appear from the Book it self, which I cannot so well express in writing. Their Paper is generally very thin and fine, and very transparent, but brown, so that what ever is Written or Printed on it, is almost as Legible
on

on the back, as on the fore-side which is of great use in the cutting of their stamps. And thence they never write or print on both sides of the same leaf but only on one, and to make the leaf appear printed on both sides they double the sheet with the printed sides outwards, and putting the folded part forward, they sew, bind or stitch together, all these sheets by the cut edges, and upon whole sheets instead of single leaves; just in the same manner as the plate annexed to this discourse is printed. They begin the book on the top of the right hand side of the page that is next the right hand, and they read downwards to the bottom, then begin the next line towards the left hand at the top, and so read to the bottom, and so proceed to the end of the book. But this I suppose not to be the primitive or first way of writing or reading. The Title of the Book is set first upon a whole Leaf, usually of a thicker Paper, and some Title is likewise written upon the folding or edge of every Sheet, where is set also the Number of the Book, and the number of the Sheet, half of which appears on one side, and half on the other side of the fold.

As to the Character it self, (I find by all the books and writings I have yet met with of that kind) that each of them is made up of a certain number of strokes, lines, or marks, which are very distinct from each other in their shape and position, and by reason that these are single strokes, and as I conceive uncompounded, I think they may be called the Letters, Elements, or Particles, out of which the more compounded Characters are constructed or contexted. These are the first kind of which there are but a very few, And I think those I have described in the 13th line of the Plate are all.

Two, three, four, or more of these joynd together in a certain order and contexture (in the doing of which there is a great Regularity and order observed, which is not varied from, and all within the regular square space) I conceive do make Syllables or Primitive Radical Characters,

each of which have a primitive single or distinct notion or signification as well as sound, which is made much use of in the more compounded Characters or Words. Of this kind I take the Figures of the Numbers to be: If at least they are not single Letters like the way of expressing Numbers in the *Hebrew Greek Arabick*, &c, Languages, for though there may be two or three of the single strokes joynd together into a compound Character, it hinders not, but that it may still signify a Letter, as in the *Greek* Α.Α.Δ.Ι.Γ.Π.Τ. In the *Runick*; where every Letter hath one upright line and some other additional marks: In the *Roman* I.L.F.E.O.Q.V. Y: Or it may signify a Syllable as in the *Æthiopick*, and in the *Hanscret*, and *Sunscrit* Languages and Characters: The first of which being the *Brackmans* Character we find in *P. Kircher's China Illustrata*, described by *P. Roth* who studyed it 7 Years; and the second (being a Literal Character used over all *India* by the Merchants) I have seen in a Transcript, brought lately out of *India* by a very Worthy Gentleman who lived there many Years, and had the curiosity to cause to be transcribed and translated also into English, A Dictionary of their Language in their own Character: who did me the favour to let me peruse it.

In which Characters or ways of Writing a Vowel is always joynd with a Consonant into one compound Character to make it effable. And then the single strokes may be taken for single Ineffable Letters as are the Consonants, and the Composition of two or three (of which one at least may be a Vowel) will make Syllables.

Of this kind, there are not so many in the whole *Chinese* Character, but that it will be easy enough to assigne each a proper Monasyllable which shall only have one or two Consonants, and one or two Vowels: That is the Consonants together and not separate, either both behind the Vowel or Vowels, if it be a diphthong or both after it or them.

Of this kind, I understand there are about 500. probably $8 \times 8 \times 8$. or 512. I could enumerate a great many, and give you also the name or words by which they are pronounced as also their signification, but (as I said before) first, I conceive the present *Chinese* Language to have no affinity at all with the Character, the true primitive, or first Language, or Pronunciation of it, haveing been lost. And secondly, I want some further help to make a full and compleat Discovery: what I have learnt from the Book of *Fohi* I shall give the next opportunity; which will explain the reason of the multiplication of 8. and the order and method of places in the Letter or word Square.

The third sort of Characters, is a decompounded sort being made up of two three or more of those of the second kind, diminished proportionably in their size, either as to their length, or breadth, or both, from what they have in the same Writing when they are single and fill up the whole Letter Square or Words Square. For there being several of them to be crowded together within the same Square, according as there are more in number, so they are always more squeezed together. In this Decomposed sort, there is a Regular order observed in the placing of the several Characters of the 2d. sort; there being some that are always on the Left side, some always on the Right, some at the top, some at the bottom. Of which I doubt not but that they have a certain Regular Method, which had we Dictionarys, explained would be easie enough to be Discovered.

This method alone of crowding together all the Characters (how many soever go to make up the decompounded Character) into one square (which is of the same size for the most Simple and for the most Compound) seems to be the great Singularity, by which the *Chinese* Characters differ from those of all the rest of the World. And this I conceive has been the Reason why all People, and possibly even the very *Chinese* themselves have, and do beleive it to be a Real and not a Literal Character: For if the Primitive Lan-

guage, or Pronuntiati^on of the Characters be lost (as I conceive it is) and that the disposition, order, method, texture, or manner of placing the more Simple in the more Compounded Characters be also lost, forgotten, or not understood ; then the whole Characters becomes a Real and not a Litteral Character : And an Immethodical one to such as want a method, that must be learnt by rote and depend wholly upon the strength of the Memory to retain it. But I conceive it might be at first either a Litteral Character, and so the whole square Character was composed of so many distinct Letters or Syllables, which composed the word signified thereby ; And so there might be a regular order of placing these Letters in the Character, That is, that the whole square being divided into so many parts, there was a Rule which was the first 2^d. 3^d. and 4th. place ; so that there being placed in those the several Letters that made up the word, according to the order they had in the word, it was easy by that Rule to Decipher the said Character, and thence to find the word and the Signification, As Regularly as if the Letters had been written one after another, as most other Litteral Characters we know are at this day written.

Or Secondly, it might be a Real Character consisting of divers Marks or Letters, that expressed so many simple Notions, several of which joyned together might make up the more compounded Characters, of which I have added some examples in the Plate which may be also made Litteral and Pronouncable, tho' that consideration were not made use of when they were first invented. What things I have Observed in my *Chinese* Books that seem to respect this method, I will give more particulars of by the next opportunity, by Printing a Specimew of the Book *Ye-kim* which explicated by these Notions will I conceive appear more Intelligible, than by the accounts we find given of it by the *Chinese* commentators, and those that have translated them into Latine, who seem not to have understood the true design thereof: for
both

both the *Chinese* and *European* Commentators assert it to be a Conjuring Book, or a Book to tell Fortunes by, and to be made use of by the *Chinese* for that purpose; whereas by the small Specimen I have seen of it, I conceive it to contain the whole Ground, Rule or Grammer, of their Character, Language and Philosophy, and that by the understanding of it, the Foundation and Rule of their Language and Character, may be without much difficulty Deciphered and Understood.

The present use of this Character, I conceive to be differing from what it was at first, both as to the position of Writing and Reading it, and as to the Expression and Pronunciation thereof,

For the way of Writing and Reading it, I conceive might at first be exactly the same with that of the *Greeks*, *Romans*, *English*, and all other *European* Nations, and also the *Æthiopic* and *Coptick*. That is, they began at the the top of the Page towards the left Hand, and so proceeded towards the right in the *Horizontal* Line to the end of it, and then began at the left end of the next line under the first and proceeded with that in the same manner, and so with the next under that and all the remaining. Continuing to Write the words of the line towards the right Hand, and the lines of the Page one under another till the whole Discourse were compleated, joyning leaf to leaf one under another, after the same manner as the Roules are at present Writ, and as the *Volumina* were of the *Antients*. And to make the parts of the Volume to be the more easily to be come at, without the trouble of Rouling and unrouling as the Ancient *Romans* did, and we do with our Roules they contrived to fold them, like the folds of a Fan, forwards and backward: and so stitching them together, that the written sides might lye outwards, and open freely one from another, and the fair sides might meet together, It came to make the present form of their book, which being laid as we generally place our books before us, they seem to begin at the top of the page on the Right-hand, and to proceed to the bottom, and then at the
top

top of the next line towards the Left-hand, and descend as in the former ; proceeding in this order with all the rest, which way must needs be very Inconvenient for writing, however they may use their Pencil differing from our Pen. Though there be a way of Writing from the top to the bottom of the Page, which is very convenient for Writing the Syriack, as also for Writing Latine, English, or Greek where the Writing is to be used for cutting the stamps of Wood, or Graving of Copper Plates with the same Character for Printing, in which Cases the Letters must be written backwards.

Secondly, as to the Pronunciation of this Character, by the Court Language, or by any other now used, I conceive it to be wholly differing from that of a Litteral Character, that is from being pronounced or spoken according to the Marks or Figures thereof, whether they be simple or compounded and made up of Simple Characters (though there are some instances of affinity in Characters and Words.) The reason of which differing pronunciation I conceive may have proceeded, partly from the loss of the Primitive Language, for which it was made, partly from a most inconvenient affectation of Monasyllabical Words in this Court Language, to help the poverty of which, they are fain to make one Syllable to signify many differing Notions, to do which they have introduced a kind of Musical toning or accenting of each of them, and that not single but compound of two or three tones to each signification of every one of these Monasyllables : Partly from the using of this way of Writing, by divers Nations of Differing Languages, who minding only the Figure and Signification, Read it into their own Mother Tongues, as we in *Europe* do Arithmetical Figures : and partly, also from the omission of most Grammatical Distinctions, the same Character serving for Substantive and Adjective, Singular and Plural, in all Cases, (save only they have some Characters for Particles as *of* and *to* in English) for the Verb in all Tenses, and numbers, &c.

for the Abstract and the concrete Signification, and for divers Metaphorical; if at least the Interpretation I have met with in the Books I have perused be exact: Partly, also from the *Syntaxis* of them, it being necessary to consider the whole Sentence to Discover which Part of Speech each Character is of, in that Sentence, wherein the order and positions of the Characters to one another, for which they have Rules, hath its Signification: And lastly, from the loss of the very Notion of a Literal Character, whence for the Expressing of Proper Names, they are fain to make use of several Characters, whose sounds or words come nearest to the sounds of the Syllables of that Name, as in the Plate *tam, jo, van.* for *Adam. Jovan*

Now, though I conceive this Character is not Effable properly as a Literal Character by any of their present Languages, And though possibly it might be at first a Real Character, that is each of them compounded of such strokes or marks as by their Figures Positions and Numbers in the Square, denoted the several Philosophical Ingredients, that made up the Notion of the whole Character, as the book *Te Kim* seems to shew by giving Rules as I conceive for the Order and Significancy of places in the Square; &c. Yet I think it not difficult to make it a Litteral or at least a Syllabical Character, and Legible into a Language somewhat after the manner of the Universal Character I mention'd before. And tho' this would not be the Primitive Language for which it was made, yet for the present uses of it (the chiefest of which is the assisting and refreshing the memory, and helping the imagination by proper sounds) it might be as good: wherein the single Characters might be Monosyllables and the compounded disyllables trissyllables, &c. According to the Number and Order of Simple Characters in the Square of the Compounded. And I am apt to think that the present pronounciation of Languages, as of *Hebrew Syriack Arabick Greek and Latine* or any other Language that has been

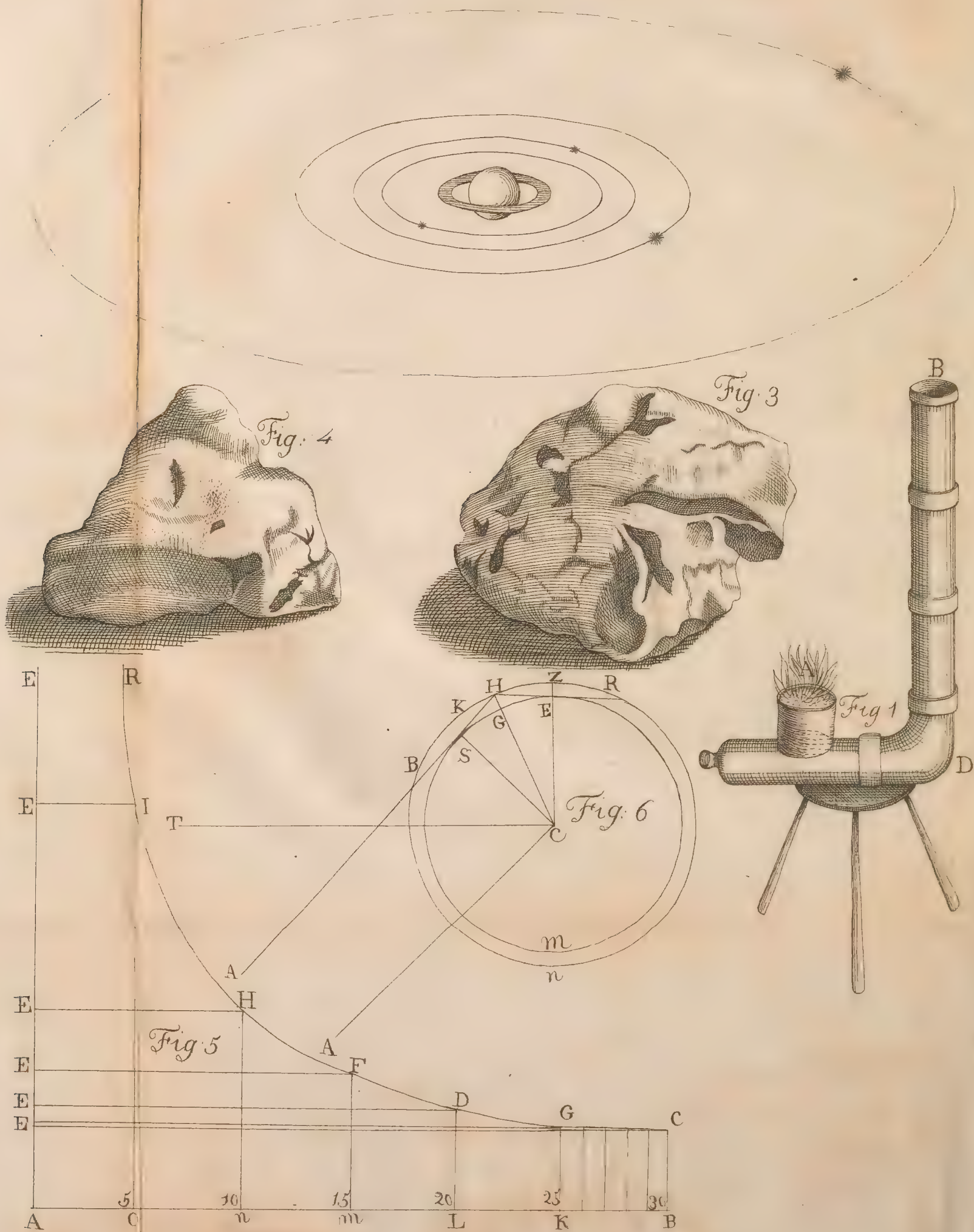
so long written, may be as much differing from what it was 2000 Years since, as an Arbitrary one now invented, and grounded on the Letters, might possibly be. And such an Arbitrary pronounciation if generally agreed upon might serve *As well* for a help to learn the Signification of words, or *Word Combinations* of Characters, as if we now knew the exact Primitive Pronounciations, as Critically as the *Masoretha* are said to have done that of the *Hebrew*; and possibly also *Much Better*, for that by such a one a great many Irregularities and Difficulties of Pronounciation (which are to be found in all Languages now spoken) might be omitted, and the whole made exactly Regular and easy, as might be shown in the *Hebrew* and *Greek*, and especially in the *Arabick*, whose difficulties are sufficiently manifested by *Alphabetum Ara'icum*, Printed at *Rome* 1592. Now as by such a Language the Character might be made Effable without Mulical Tones or Difficult Aspirations, so had we Dictionarys of the Signification of the Characters, we might as soon learn the *Chinese* Character, as we can *Latine*, or any other Language to be Learnt by Book, and not by Speaking.

IMPRIMATUR,

John Hoskyns Vice P. R. S.
July 17th 1686.

Printed by *J. Streater*, and are to be sold by *Sam. Smith*
at the Sign of the *Princes's Arms* in *St. Paul's Church yard*.

Orbitæ quatuor Interiorum Satellitum Saturni
cum Ansa omnium maxime diducta conspiciuntur.



*Satellitum Saturni
diducta conspicuntur*



PHILOSOPHICAL

TRANSACTIONS.

May the 25th. 1686.

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An

An Account of an Engine that consumes Smoak, shown lately at St. Germans Fair in Paris Communicated by Mr. Justell R.S.S.

TO burn all sorts of Wood in the middle of a Room without making any Smoak, is a thing so extraordinary, that all those that have heard speak of it, as well Philosophers as others, have asserted it impossible: but Mr. Dalesme Engineer, prosecuting his discoveries, has found out a Machine, which tho' very little and portable, consumes all the Smoak of all sorts of Wood whatsoever, and that so, that the most curious eye cannot discover it in the Room, nor the nicest Nose smell it, altho' the Fire be perfectly open. This has given such satisfaction to all that have seen it, and to the King himself, that he has caused the Experiment to be made several times before Him.

This Engine is made after the manner represented in Fig. 1. and is composed of several hoops of hammer'd Iron of about 4 or 5 Inches diameter, which shut one into the other: It stands upright in the middle of the Room, upon a sort of Trevet made on purpose. A is the place where the Fire is made, where if you put little peices of Wood, it will not make the least smoak, neither at A nor B, over which you cannot hold your hand within half a foot, there comes out so great a heat: If you take one of these peices of Wood, out of the Fire at A, it smoaks presently, but ceases immediately so soon as it is cast in the Fire again. The most fatid things, as a Coal steeped in Cats-piss, which stinks abominably when taken out of the Fire, notwithstanding in this Engine makes not the least ill scent. The same did Red-Herrings broiled thereon; on the other side all perfumes are lost in it, and Encense makes no smell at all, when burnt therein. We have since learnt that this is not shown, but when the Fire at A is well kindled, and the Tunnel B D very hot, so that the Air that feeds the Fire cannot come that way, but must all press in upon the open Fire; whereby the Smoak and Flame is all forced inwards, and must pass through the heap of burning Coals in the Furnace A, in which passage the parts thereof are so dispersed and refined, that they become inoffensive both to the Eye and Nose.

*An Extract of the Journal Des Scavans. of April 22
st. N. 1686. Giving an account of two new Satel-
lites of Saturn, discovered lately by Mr. Cassini at
the Royal Observatory at Paris.*

THE Variety of wonderful Discoveries, which have been made this Century in the Heavens, since the invention of the *Telescope*, and the great Utility that may possibly be drawn therefrom, for perfecting natural Knowledge, and the Arts necessary to the Commerce and Society of Mankind, has incited Astronomers more strictly to Examine, if there were not yet something considerable, that had not been hitherto perceived.

The diligence of those that have gon before, having left only the most difficult and obscure Objects to discover, these *Satellites* of *Saturn* which are eminently so, by reason of their Smallness and great Distance from the Sun and Earth, have fallen to the share of *Sign. Cassini*; who being furnished with *Telescopes* of an extraordinary length and goodness, has been able to see deeper into the Heavens, than those that have hitherto attempted. *Mr. Hugen*s indeed found out one of them, *viz.* the fourth and biggest about thirty Years since, and made out the Theory of the *Ring* or *Ansa* of *Saturn* till then unknown; but it seems there remained yet four others to discover. The middlemost and outermost, or third and fift *Sign. Cassini* discovered in the years 1671, 72 and 73, an account whereof is to be seen at large in Number 92 of these Transactions; the two innermost were reserved to this present time for the same Observer, having now lately gotten yet better *Telescopes*. The account he gives of these Discoverys is as follows.

L

The

The Distance and Period of the first Satellite.

The first or innermost *Satellite* of *Saturn*, by the Observations hitherto made, is never distant from his Ring, above two thirds of the apparent length of the same Ring, which we take for the measure of the distances of these *Satellites*: and it makes one Revolution about him, in one day, 21 hours and 19 minutes. Wherefore in less than two dayes it makes two Conjunctions with *Saturn*, the one in the upper part of his Orbe, and the other in the lower part; and the Ring taking up the greatest part of the *Diameter* of the *Circle*, wherein this *Satellite* makes its Revolution, these Conjunctions are of a long continuance, in respect of the whole Revolution, it being 8 hours and half in passing the length of the Ring, which at present hides it every day for so long time; and longer too, because it is very hard to be distinguished, when it is very near the Ring.

This happens particularly for these two or three years, when the Position of the Ring, in respect of the Earth, being very Oblique, it appears very narrow; and the *Circle* of this *Satellite's Orb* being nearly in the same plain with it, they appear very close together. In the following years when the Ring and the *Orbs* of these *Satellites* shall be more open, there will be a greater distance in *Latitude* between this *Satellite* and the Ring, and it may be seen both above and below the *Ansa*, which at present cannot be.

These Conjunctions of so long duration hapning often at the times most proper to observe *Saturn*, have frequently hindred the seeing of this *Satellite*; and particularly before we had found the Rules of its Motion, so as to be able to prepare to observe it, at the times when it was far from its Conjunction. And seeing one Conjunction begins 14 hours after another is finished, and that each lasts 8 hours and half; whenever we hapned to observe after the beginning of a Conjunction, and continued the following days to observe
about

about the same hour, there would be 9 or 10 days wherein this *Satellite* could not at all be seen, for this only reason: and if the course of the Observations were interrupted by ill Weather or any other cause, it has been above 20 or 22 days before it could be seen again: So it hapned soon after the first discovery thereof, the which has for this cause been incomparably more difficult to make, than any other hitherto made.

The Distance and Period of the second Satellite.

The second or penintime *Satellite* of *Saturn*, according to the Observations hitherto made, is but three quarters of the length of his Ring distant therefrom, and makes his Revolution about him in 2 days, 17 hours and 43 minutes.

There seldome passes a day wherein it is not joyned to *Saturn*, either in the upper or lower part of its *Orb*. The Conjunctions or times wherein it passes the whole length of the Ring, last 8 hours; and 25 hours after one ends another begins. By reason that at first it could not be distinguished, when it was not at a good distance from the Ring, and before we had found out the Rules of its Motion, to foresee the times proper to observe it, we were several days without seeing it. Afterwards it was discovered one day to the *Eastward*, the next day to the *Westward*, and the third or fourth day at the same hour, it was again in Conjunction with *Saturn*: and so because the first for several days together could not be seen at the same hour, it often hapned that neither the one nor the other was Visible, and when one began to appear, it was uncertain which of the two it was, both of them shewing themselves alternately, on day on the *East* side, and the next day on the *West* side.

This distinction was still more difficult, for that the difference of their Elongations is so little, that for the most part the second *Satellite* is found within the limits of the E-

longations of the first, which likewise made it hard to determine their Degressions. It was not without a great number of choise Observations, that it was concluded that the proportion of the digression of the second, to that of the first, counting both from the Center of *Saturn*, is as 22 to 17.

The Rule of the Proportion, that is between the Distances and the times of their Periods.

The time wherein the second *Satellite* makes its Revolution, is to the time wherein the first makes its, is as $24\frac{1}{4}$ to 17, which is a greater Proportion by half a Degree than that of the Distances, viz. 22 to 17. This is that very same Proportion which *Kepler* observes, between the Distances & Periods of the primary *Planets*, and which we have found between the other *Satellites* of *Saturn*, upon our former discovery, and is verified in the *Satellites* of *Jupiter*. There is nothing that better shews the admirable Harmony of the particular Systemes, with the great Systeme of the World.

The Number of the Conjunctions, of these Satellites with Saturn.

Of all the *Satellites* that are, there are no two so near placed to their primary *Planet*, as these two *Satellites* of *Saturn*, and which taken both together make so great a number of Conjunctions with their *Planet* in the same space of time; for there are in all no less than 653 in a year, whereas the two first *Satellites* of *Jupiter* make, one with another, but 617; the first of *Saturn*'s, makes its Revolution in 3 hours longer time than the first of *Jupiters*, but *Saturn*'s second has its Period 9 hours and half shorter than *Jupiters* second *Satellite*.

The

The Glasses used to make these Discoveries.

The Distance of these two *Planets*, which is almost Infinite in respect of their Magnitude, had kept them yet much longer concealed, if we had not for this purpose made use of Glasses of extraordinary Force. They were first of all seen in *March Anno 1684*, by two excellent Object Glasses of 100 and 136 feet, and afterwards by two others of 90 and 70 feet, all made by *Sigr. Campani* and sent from *Rome* to the Royal Observatory by the Kings order, after the discovery of the third and fifth *Satellites*, which had been made by others of his Glasses of 47 and 34 feet. We made use of them without *Tubes*, by a more simple contrivance than those proposed either before or since. We have since seen all these *Satellites* with that of 34 feet, and continued to observe them with Glasses of *Mr. Borelli* of 40 and 70 feet, and by those which *Mr. Arrouquel* hath lately made, of 80, 155 and 220 feet. It was easy for us to see these two *Satellites* by these different sorts of Glasses, after having found the Rules of their Motion, whereby we might with more particular attention look upon the places where they ought to be.

We placed these great Glasses sometimes upon the Observatory, sometimes upon great Masts, sometimes upon the Tower of Wood, which his Majesty has caused to be brought for this purpose from *Marly*, upon the Terraces of the Observatory. Lastly we put them in a *Tube* raised upon a support made like a Ladder with three leggs, which had all the success we desired.

After having distinguished these 2 *Satellites* from the fixt Starrs, from the other *Satellites* of *Saturn*, and from each other, and found the periods of their Motion, we have established *Epochæ* from Observations, as near as we could to the Conjunctions.

Ra-

Radices or Epochæ of their Motions.

The first *Satellite* was observed 45 degrees distant from its Perigee, moving towards the *West*, March 11th 1686 ft N. at 10 h. 40 min. at night, and returned to the same position on the 14th. of *April* at the same hour.

The second was 36 degrees distant from the Perigee to the *West*, the 30th of March 1686 ft. N. at 8 of the clock in the evening.

A Comparison of the Revolutions of Saturns Satellites with Jupiters.

It were too much at this time, to give all we have observed of the other *Satellites*, but we cannot miss comparing the Periods of the *Satellites* of *Saturn* with those of *Jupiter*, after the following manner, by which it appears that the *Satellites* of *Saturn* in the same order, performe their *Revolutions* in less time, than those of *Jupiter*, that answer to them; except the first, as may be seen in this Table.

	day	hour	min.
<i>The first Satellite of Jupiter revolves in</i>	1	18	29
<i>The first Satellite of Saturn in</i>	1	21	19
<hr/>			
<i>The second of Saturn in</i>	2	17	43
<i>The second of Jupiter in</i>	3	13	19
<hr/>			
<i>The third of Saturn in</i>	4	12	27
<i>The third of Jupiter in</i>	7	4	0
<hr/>			
<i>The fourth of Saturn in</i>	15	23	15
<i>The fourth of Jupiter in</i>	16	18	5
<hr/>			
<i>The fifth of Saturn in</i>	79	21	0

These are the particulars of the Discovery, whereby the admirable Analogy and Uniformity of the parts of the Universe are most evident, and the Infinite Wisdom and Power of the Creator is demonstrated to the Contemplative. In the Conclusion, the Discoverer considers that the Ancient Astronomers, having translated the Names of their Heroes among the Stars, those Names have continued down to us unchanged, notwithstanding the endeavour of following Ages to alter them; and that *Galileo*, after their Example, had honoured the House of the *Medici* with the discovery of the *Satellites* of *Jupiter*, made by him under the Protection of *Cosmus II*; which Stars will be always known by the Name of *Sidera Medicea*. Wherefore he concludes that the *Satellites* of *Saturn*, being much more exalted and more difficult to discover, are not unworthy to bear the Name of *Louis le Grand*, under whose Reign and in whose Observatory the same have been detected, which therefore he calls *Sidera Lodoicea*, not doubting but to have perpetuated the Name of that King, by a Monument much more lasting than those of Brass and Marble, which shall be erected to his Memory.

In our Figure we have omitted the Orbe of the outer *Satellite*, that so the rest might not be crowded, but its distance to that of *Hugenius's*, is as Cube Root of 25 or 2,925 to 1.

Two Astronomical Observations of the Eclipses of the Planet Jupiter, by the Moon in March and April last, made at London.

The *Lipsick Ephemerides* of Mr. *Godfrid Kirck*, giving notice of these Occultations, they were thought of too great consequence to be neglected, if the weather proved fair. The first hapned *March 31th.* at night, and was attended with a most Serene Sky, no Clouds any where appearing, wherefore Mr. *Hook* and E. *Halley* undertook the Observation in
Gresham

Gresham Colledge; which succeeded as follows. Having taken some good Notes for the rectifying the *Pendulum* Clock, they expected the rising of the Moon, so much the rather, for that it was doubtful, whether the Planet would be eclipsed at the Rising or no, for tho' *Kirk's Ephemerides* made the Immersion at 9 h. 46 m. at *Lipsick*; that is at *London* 8 h. 54 m. yet his *Jupiters* place being 13 m. too slow, it was plain that the Occultation would be very near the Horizon of *London*. Accordingly at 9 h. 26 m. the under Limb of the Moon, was just risen over *Shooters Hill*, and soon after *Jupiter* appeared near the Eastern Limb of the Moon, within a few Minutes of being eclipsed.

9 h. 33 m. As near as could be guessed, was the Time of the central Immersion, which was very difficult to be observed, by reason of the Asperity of the Moons Limb, which undulated and sparkled very much, as it appeared through the Vapours near the Horizon, so that the contact of the Limbs could with no certainty be determined: The Ingress happened much about the length of the Spot, called by *Hevelius* *palus Mareotis*, to the North of the said Spot, or about the 124th. Degree of the outer Limb of his *Selenography*, nearly in the same Latitude with the Moons Center.

10 h. 30 m. The Western Edg of *Jupiter* began to emerge out of the dark Limb of the Moon:

10 h. 31 m. 20 s. The whole disk of *Jupiter* was entire, so that he was about a minute and a third in coming out from behind the Moon, whereby the Diameter of this Planet may be determined.

The Emersion was exactly in a right Line with the Moons Center, and the Northern Part of *Palus Maotis*, or about the 324th degree of the inner Limb of the *Selenographic* Table of *Hevelius*.

The other Occultation hapned *May* the 28th. *Mane*, or Astronomically, the 27th after mid-night; the preceding Night was cloudy dark Weather; so that there was no encouragement to set up for it; however by good hap, both

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Immersion and Emerfion were observed.

The Immersion was feen at *Totteridg* (which place is about 9 *Miles* from *London*, and nearly 25 *seconds* of time to the *Westwards* thereof) by Mr. *Edward Haines*, a Member of the R. *Society*, well verſt in this fort of Obſervation: who between a gap of the Clouds obſerved the Contact of the *Moons* limb and *Jupiters*, at 15h. 3½ min. the Clouds cloſing again permitted him to obſerve no more, however from this we may conclude the Central Immersion at *London*, to have been 15h. 4½ min.

The Emerfion was obſerved at *London* by *E. Halley*, to fall out at 15h. 49 min; for at 15h. 50 min. *Jupiter* was all out, and the limbs ſo little ſeperated, that he judged, that a minute before, the center of *Jupiter* had been upon the *Moons* edg: The point of the Emerfion was over againſt the *Southern* part of the ſpot, called by *Hevelius* *Infula Macra*, or at the 342d diviſion of the inner limb of his Mapp of the *Moon*.

What has been obſerved of theſe two Occultations elſewhere, would be very acceptable to the R. *Society*; ſuch ſort of Obſervations, if accurate, being of ſingular uſe to determine the *Longitudes* of Places, eſpecially thoſe that are far remote; for which purpoſe all Curious Perſons furniſhed with Inſtruments and Skill in *Aſtronomical* matters, are deſired to let ſlip none of theſe opportunities, which may be of ſo great benefit to *Geography*.

A Discourse on this PROBLEM;

Why Bodies dissolved in Menstrua Specifically lighter than themselves, swim therein.

By Mr. *WILLIAM MOLYNEUX*, of *Dublin*.
Member of the *Royal Society*.

THE Liberty of Philosophising being now universally Granted between all men, I am sure that a difference in Opinion will be no breach of affection between two intirely Loveing Brothers: And therefore I shall take the freedom to Propose my Own thoughts in a matter wherein my Brother Mr. *Thomas Molyneux* hath Appeard publickly in the *Novelles de la Republique des Letres*, *Mois d' Aout 1684. Art 4.* and *Mois de Janvier 1685. Art 7.* The Problem proposed is, *Why Bodies dissolved float in Liquors lighter than themselves*; as for Example: Mercury dissolved in strong Spirit of Niter swims therein, tho' each small Particle of Mercury, be far heavier than so much of the Liquor whose place it occupies. This, says he, cannot be solved by the prime Law of Hydrostaticks, which is, that a Body which in an equal Quantity is heavier then a like quantity of Liquor, sinks in that Liquor; thus a Cubick Inch of Iron being heavier then a Cubick Inch of *Aqua-Fortis*, and each Particle (how small soever) of Iron being heavier then a like Particle of *Aqua-Fortis*; Iron being put into *Aqua-Fortis* should sink, and yet we find, that Iron being dissolved in a convenient Quantity of *Aqua-Fortis* floats therein, and does not fall to the Bottom. The Reason which my Brother gives for this is, that the Internal Motion of the Parts of the Liquor, does keep up the Particles of the dissolved Solid, for they being

so

so very Minute, are Movable by the least Force imaginable, and the Action of the Particles of the *Menstruum*, is sufficient to drive the Atomes of the dissolved solid Body from place to place; and consequently, notwithstanding their Gravity, they do not sink in the Liquor lighter than themselves. As a Proof of this in the 7th. Article of *Janvier* 1685, he offers an Experiment known in *Chymistry*, that a *Menstruum* over a digesting Fire (as the *Chymist* speaks) will dissolve a greater Quantity of a Body put into it, than when tis off the Fire, and if it be taken off the Fire, and suffered to cool, a great Portion will precipitate of that which was perfectly dissolved, whilst the *Menstruum* continued hot. For, *says he*, the Particles of the *Menstruum* acquire a more violent agitation by the Fire, and are therefore able to raise and keep up a greater Quantity of the dissolved Body, or hereby they are able to Resist a greater Gravity.

It has been objected against this Notion, that the common Experiment of precipitation, by mixing an *Alkaly* with an *Acid* seems to contradict this; for thereby the Fluidity of the *Menstruum* is not taken away, and consequently, the internal Agitation of its Parts is not diminished, and yet thereupon, the Particles of the dissolved Body precipitate all to the Bottom. To this he answers in the forecited Article of *January*, that all Mixtures of different Liquors introduce in each a different Conformation of Pores, and therefore the Infusion of a new Liquor, drives the insensible Parts of the dissolved Body from their Places, and forces them to strike against each other, and cling together, and so becoming more big and heavier than formerly, the internal Agitation of the Liquor is no longer able to move and sustain them, and consequently they fall to the Bottom.

This, as fairly and shortly as I can propose it, is his Sentiment of this Phenomenon.

But I conceive an other Account may be given of this Appearance, and that the foreſaid Law of *Hydroſtatics* is a little deficient. Tis true indeed, if we conſider only the ſpecifick Gravity of a Liquor, and the ſpecifick Gravity of a ſolid Particle floating therein, the forementioned Rule is exact; but in ſinking there is requiſite a ſeparation of the Parts of the Liquor by the ſinking Body; and there being a natural Inclination in the Parts of all Liquors to Union ariſing from an Agreement or Congruity of their Parts, there is a reſiſtance therein to any thing that ſeparates this Conjunction: Now unleſs a Body have weight enough to overcome this Congruity or Union of Parts, ſuch a Body will float in a Liquor ſpecifically lighter then it ſelf. But that a heavy Body, as *Mercury* or *Iron* may have its Parts reduced to that Minuteness, that their Gravity or Tendency downwards, is not ſtrong enough to ſeperate the Cohesion or Union of the Parts of a Liquor, will be manifeſt, if we conſider, that the Reſiſtance made by the *Medium* to a falling Body, is according to the Superficies of the Body; but as the Body decreases in Bulk, its Superficies does not proportionably decrease, thus a Sphere of an Inch Diameter, has not eight times leſs Superficies than a Sphere of two Inches Diameter, tho' it have eight times leſs Bulk, and conſequently paſſing through a *Medium*, as ſuppoſe Air or Water, the Sphere of an Inch Diameter is, proportionably to its Bulk, more reſiſted, than a Sphere of two Inches Diameter in proportion to its Bulk, and hence it will come to paſs, that at laſt a Body may be reduced to that Minuteness, that its Gravity preſſing downwards (which is according to its Bulk) may be leſs than the reſiſtance of the *Medium*, which operates on the Surface of the Body; ſeeing as I ſayd before, the Surfaces of Bodys do not decrease ſo faſt as their Bulks, theſe decreasing in a *TriPLICATE*, but thoſe in a *Duplicate Ratio* of the Bodies Diameters.

This Account does not at all oppoſe the Experiment of a *Menſtrum* over the Fire, being able to diſſolve or ſuſtain

a greater Quantity of a heavy Body; for the Reason of this, as 'tis given by my Brother, does not Contradict my Notion. The Account likewise, that He gives of Chymical Precipitation agrees very well with what I propose: So that of these I shall say no more.

But because in the beginning of my Discourse, I say that the forementioned Law of *Hydrostaticks* is a little defective, I desire to explain my self a little further in that Point. In Weights falling through the Air, were Gravity only consider'd, the Proportions of their Descents would be exactly as *Galileo* has Demonstrated; but it is allow'd by all, that the Resistance of the Air, not being consider'd in those Demonstrations, they are not Mathematically true in Practise, but that Really there is something of that Proportion hindred by the Airs Resistance. Now, what is this less than to say, that the Resistance of the Air takes off some of the Operation of Gravity, or is able to withstand or oppose part of its Action? And if so, what shall we say were an Iron Sphere let through a Medium of Water? Surely the Proportions of its descents would be much more disturbed herein, as Water is much more Solid and difficult to be seperated or passed through than Air, and consequently we must needs Graunt, that more of the Operation of Gravity, is taken off or Resisted by this Opposition of the Water, than that of the Air. And if so, Surely there may be a certain degree of Gravity, that may be quite taken off by the Resistance of the Water: Were a Pistol Bullet let fall through the Air, it would Descend imperceptibly nigh the Proportions that *Galileo* has assigned, but were a single grain of Sand so let fall, it would be much hindred in its Course, and the half of this Grain would be more obstructed; what shall we then say of the ten thousandth part, or of a part the ten thousand millionth of this, and again of the Infinite Subdivisions of that, till at last we come to a part that would be wholly resisted, or kept up;
such

such as I conceive the Minute particles of a Body dissolved in a *Menstruum*.

On this account 'tis I say, that the forementioned Principle of *Hydrostaticks* is a little defective; for it considers not the Natural Congruity of the Parts of a Liquor, whereby they desire, as't were, to unite and keep together, just as we see two Drops of Water on a Dry Board being brought together do jump and Coalesce, and therefore Liquors have an innate power of Resisting a certain degree of force that would seperate them; such as I suppose the degree of Gravity, in the most Minute Particles of a Body dissolved in a *Menstruum*.

The forementioned Rule holds true to the most nice Sence in Great Bodys, but in those that are by many Millions of Divisions Smaller, it seems to fails.

This in short is my Conjecture in this matter, which I propose, as my Brother did his, with all submission imaginable, and thereby to give occasion to others to enquire into the Causes of this appearance, rather then to publish my own sentiments as the undoubted solution thereof.

But this I must acknowledg, that the Internall motion of the parts of a Liquor seems so very agreeable to truth, and explicates so many Phænomena easily and plainly, that I would not be thought to deny it. Neither would I be thought wholly to Reject my Brothers solution of this Problem; for certainly that Motion (what soever it is) in a *Menstruum*, which is able to Dissolve such a solid Body as Iron, that is, which is able to disturb the close and strong Cohesion of the Parts of Iron, may very well be supposed sufficient to disturb or keep up these parts from resting in the Bottom of the Vessell, wherein the solution was made; And certainly no better account can possibly be given of such solutions, than by supposing such an Internall motion in the Parts of the *Menstruum* insinuating themselves into the solid body, and loosening its Parts. And tho it may be objected, that in the Parts of Water there may be supposed as Violent

lent an Internall motion, as in the Parts of *Aqua-Fortis*, and yet we see Water will not dissolve Iron, as *Aqua-Fortis* does, and Common Bees-Wax is disturbed by neither of them, I leave the Nice enquiry after this point to others, *viz*, What kind of Motion and peculiar Conformation of parts is requisite both in the *Menstruum* and in the Dissolved Body, that a solution may result from their Commixture.

Some Reflections on the foregoing Paper by Mr. T. M.

What my Brother has laid down in this Discourse, I think does most undeniably evince that the received Law of *Hydrostaticks* is somewhat defective. For Liquors, tho' they are Fluid yet they are Bodys, and therefore consist of parts united; which Union tho' it be easily destroy'd, yet of necessity it requires some degree of Force for the effecting it; nor is it more manifest, if rightly considered, that a Flint requires Force for the separation of it's parts, than that Fluids do for theirs. But however, I imagine, this Property ought not to be rely'd upon as the sole Cause of this Appearance, to which my Brother has apply'd it; nay perhaps does not so much as concurr the least in the producing this effect; my Reason in short is this: whatever is of sufficient Power to raise the minute Particles of a *Heavy Body* in a light Fluid, is certainly a sufficient cause to keep them in that state: now my Supposition may give some account of this, what my Brother says, never can; for he must necessarily suppose them first raised; and then he gives the reason of their not sinking: Whereas 'tis not to be questioned but that that Force which raised them, is the same that keeps them from falling to the bottom.

But these Conjectures (for I esteeme them no more) I leave to the Consideration of those that desire to enquire further into this Matter.

A Letter of Dr. Sigismond Konig, Phyſician of Bern in Swiſſerland, to the Royal Society, being a continuation of the Hiſtory of his Patient Margaret Lower; an Account whereof is given in the third Philoſophical Collection, of December 10th. 1681.

Illuſtres Nöbiliffimi doctiffimiq; Viri.

TAcito tempora grefſu diffugiunt, nulloq; ſono Annus vertitur, vite emblemata quibus meſuramur, incitamurq; ea, quæ alicujus boni eſſe poſſunt, ne ſero ſuspendamus: moti unde, licet adhuc immaturum fructum decerpere, Hiſtoriamq; de petrificata noſtra, (cujus obitum inane expectavimus) continuare, quam occultare malluimus; ne aut Phenomini hætenus nihil contigiffe, aut non obſervaffe putemur. Videmus enim hinc et inde Hiſtoriam iſtam grate acceptam, varijs prælis mandatam, ſed non æqualiter ad ſenſum verborum tranſlatam vel examinatam eſſe; plurimosq; doctos hæc, etſi pauca, ob caſus infrequentiam, admirari, progreſſum monere, quosdam vero ad ſortilegia, vel inter iſtas ſpecies referre, quæ fidem oculumq; fallant: Aſſentirer forſan, niſi ſummus naturæ Author in hac prius imperſcrutabilia ſæpius recluderet, phyſicoq; ſcrutinio ad redundantem Neminis ſui Gloriam rimanda concederet: In hoc dum laboramus Clariffimorum Viro-
rum deſiderium nos non impleturos, ſed favorem excitaturos ſperamus.

Ab eo quo Hiſtoriam ſecunda Calendarum Octobris Anni ſeculi octo-eſimi primi pertexui, ægra noſtra moderate vixit, ſatq; bene; naturæ functionibus (ut ante relatum) in excipiendis & excernendis occupatis, ad decimam octavam Anni octo-eſimi ſecundi

di mensis Augusti, qua torqueri, nauseaq; et singultu absq; tamen vomitu agitari cœpit: dato cardiaco cum spiritu nitri dulci ad vigesimam nonam dicti mensis cessarunt symptomata; hac vero superioris & inferioris ventris cruciatibus summis angi, in latera volvi, respiratione impediri, Hysterico Paroxysmo infestari, cum ructibus, cordis palpitatione & oscitatione visa; Occurrebatur Anodynis & Antispasmodicis (omissis clysteribus, quorum usum agra ob intestinalis motus inversionem valde, horrebat.) succedebant expansiones & jactationes artuum, motus convulsivi totius abdominis, constrictio musculorum laryngis & faucium cum Aphonia, tandemq; parturientis dolor sibi o alto se dictitans, quo contractis omnibus membris, alvo dejecit insequenti, trigesima, calculum Fig. tertiæ cruore conspersum; cujus enixum sequebantur altera die duo minores longe, cum hæmorrhoidali fluxu, dilaceratis vasis: posthac instar puerperæ habita, jussulis restaurata, remediis sublevata convaleuit, intraq; septimanas paucas, resoluta jam quasi natura, ad actiones obeundas vires collegit.

Hæc rerum tristis facies & vicissitudo, hic agræ status, ab ultimis præteritorum tolerabilior, in dolorificum versus: Calculi non tantum majoris ponderis sed & durioris substantiæ, valdeq; angulosi, nec singulis digestionibus, sed velut in quadam matrice maturescentes abrupti pelluntur, tertia quartave septimana inferne nec ulterius superne excluduntur: Alvus prius libera demum adstringi incipit, & una alterave a constrictione die lapidem parturit: Urinam e vesica reddit paucam, potui in quantitate non respondentem, variam, plurimum crassam & turbidam, quæ raro supprimitur, suppressam emingendo antecedit calculus fabæ magnitudine majoris, angulosus, cæterisq; per omnia similis: Et quod antehac per intervalla, nunc quotidie contingit, mane dum urinandi motus urget, quantitate aliqua fluente per vesicam prius, nullo vel exiguo intervallo, altera vomitu decedit ad uncias tres vel quatuor, ejusdem coloris, consistentiæ, odoris urinosi, & ex agræ relatione, multifaria cum nausea, saporis; quæcumq; clarius in spagyrico examine apparere. Tumet abdomen nec solum ut ante in sinistro hypochondrio durties, lapidumq; allidentium sonitus, sed in tota ventris æextra regione aliquando profundiùs ob musculorum laxitatem sentitur, magnumq; dolorem circa hypogastrium queritur. Appetit cibam

ve modice, qui ex radice Glycyrrhiza, graminis & hordeo usualis est, perq; vices aliquid vini tenuioris conceditur. Dormiendo subsultat: Fluunt menses varius & parcius nec tamen desistunt: Pulsus habet & languidum, & celerem, & profundum, & interceptum, pro variis symptomatibus variantem: Respiratio liberior, non valida sed sensu vix perceptibilis: Mentemq; plus nunquam movetur: Tandem duodecima Decembris Anni ultimo elapsi, tiliæ dextra Gangrana ad palmæ latitudinem correpta, scarificatione caterisq; necessariis curata, nunc Angina notha, ob tonsillarum inflammationem: premitur, plurimumq; arteriosus sanguinis e faucibus fluit, majoris forsitan excernendi lapidis prodromus: revulsionem per phlebotomiam in pede & clysmata tentatam secuta fuit, vigesima Februarii, dejectio facum naturalium per inferiora; vigesima tertia vero & dejectio faculenta & rejectio per fauces oleosa clysmatis substantia, cum fatore absq; lapillis, unde imminens suffocationis metus abstinere jussit.

Hic Casus rarus & mirus varia ingenia suscitavit: Naturam enim sortilegia abhorreere cujuscunq; Philosophi sententia est; ipsam vero a limite & communi experientia in agra nostra plurimum recessisse, si quis antehac proposita Phenomena in dubium vocavit, nunc specimina credat: Majorum siquidem morborum argumentum existit gravium symptomatum concursus, quæ seorsim sumpta, etsi explicatu singula leviora videantur, juncta vero ob motus varietatem ardue pugnant.

Calculos in humano corpore, ad Macrocosmi leges, ex principiis activis, vinculo salino, cum matrice terra & phlegmate, diversimode concreescere docet Analysis; Inq; glandulosis partibus corporisq; ductibus generari nihil ignoti, quod gravissimi Authores testantur, nosterq; observatione constat, præter renum vesicæq; calculos, anno seculi septuagesimo septimo, Catarin: Scertenleib puellam, excretis tussiendo plurimis lapillis tephaceis, in Nosocomio nostro Pthysi occubuisse; E contra Sabulo multaq; pituita gypsea in intestinis concreta varie dejecta, Catarinam Blaferam Anno octogesimo in eodem hospitio integre restitutam esse; Virum Ampl. D. Joh. W. majoris Senatorii ordinis, arthriticum mense Julio Anni octogesimi tertii, utroq; uretere calculis obstructo, ab impedita mictione,
dicema

decima & septima morbi die, non juvantibus variis feri vacuationibus, Phlebotomijs & Lithontripticis, Apoplexia obiisse; quos lapides, alterius longe a nostra egrotæ substantiæ, nulloq; acido spiritu ob oleosam imprægnationem solubiles, extraxi; Ren sinister naturali duplo, dexter vero triplo major, dilatatis tunicis, multo sero tumidi scatebant, plurimis obhærentibus lapillis ruffis, asperis, cum ex ureteribus secti essent apice rotundo, forsân levigato in ductu, & forma glandis quercus minoris: Nuperisq; e tonsillis puellæ Mariæ Haffneriæ ad triginta duos tophos secuit Civitatis hujus Chirurgus expertissimus D. Albertus Baurenkoningius: Insuper a Clarissimo vestro Dn. Doctore Sclareo Historia communicata de calculis felleis raræ magnitudinis pro angustia ductus cholidochj: Et alia filij Ebrai cujusdam undecem Annorum Weinhernii in Palatinatu degentis, lapillos diversi generis, immo silices, per virgam anumq; excernentis, ab Urbis Heidelbergæ Secretario Cl. D. Zweifelio mihi perscripta.

Verum cum similia visu, reipsa plurimum dissimilia sint; ut Naturæ Cariosis oblectationem aliquam, generiq; humano solatium fructumve præstemus, accuratiusq; loquamur, Physico examini calculos hosce subjecimus.

1. Solvendo: Sic spiritus Sulphuris, Vitrioli, Aceti; affusus, aliquem effervescenti motum incipit, imprimis in ijs qui ventriculo excreti, rarioris texturæ, friabiliorisq; substantiæ sunt; sed citius, acidis suis particulis inflexos poros ingressis, subsistit, nullamq; solutionem perficit.

Salis Armoniaci Spiritus ne quicquam movet, & omni modo tentatus, veluti homogenius subjecto suo, conquiescit.

Sed Nitrosus Achilles cuncta destruendo subegit.

2. Distillando per retortam: Oesophago excreti Salis Volatilil cum spiritu & Phlegmate paucum, terræ plurimum, Salisque fixi fere nihil; Posteriores alvo redditi, cum ijs ex vesica ejusdem figuræ & substantiæ, plus Volatilil, cum paucis ad gustum subacido phlegmate, sed spiritu urinoso forti, modicum fixi salis ac plurimum terræ habebant. Calculorum horum uncia sex exhibuerunt Capitis mortui uncias quinque cum drachmis duabus, & ex his salis lixiviosi vix scrupulum cum dimidio, phlegmatis cum

Spiritu et immisto sale volatili drachmas quinq; & semis, adherente quadam portione recipientis lateribus : Hic liquor junctim sumptus, addito spiritus vini Alkolisati quanto, in Alembico exiguo caloris gradu sublimatus, deposuit in Capite salis volatilis urinosi scrupulos duos & semis. Olei nihil conceptum nisi volatiliu fluorem salium eo referre velimus.

3. *Præcipitando. Liquor distillatus spiritus Vitrioli additamento in rubram tincturam vertitur, tandemq; crassior evadens quodammodo secedit in fundum ; Affusus vero idem spiritus a distillatione residuo capiti mortuo, aut sali inde elixiviato, non aliam quam cum sale & oleo Tartari impetuosam effervescentiam excitat.*

Sic Lapides nostri constant plurima Terra, Sale Vol. exiguo, acido perpaucò, quod sale spirituq; Urinoso infractum & edulcoratum esse, spiritus Armoniaci ejusdem naturæ demonstrat, acidorum partibus immixtus eas retundendo & implicando in dulcem Saporem cogit, post non resclubiles.

Exin concludimus salium lixiviosorum naturam a salis Tartari non recedere in agra nostra ; & reperta matrice, incorporandi subiecto, accedente acido, motum (effervescentia aliqua prægressa) invicem sisti, inque calculos hosce coire ; prout Vitrioli spiritus particulis suis acutissimis & flexibilibus (unde oleosus tangitur) sal Tartari penetrando quidem destruit, sed destructum in sui naturum aliter colligando cogit : In hisce calculis, ut jam ad suam crasin dispositis, nil præstitit ; verum sal fixum, igne sublatis implicandi spiritibus, in suam naturam reduxit, ex qua coagulum constat.

E contra, Nitri spiritus acidus quidem, sed ob subtilissimi salis conjunctionem particulis rigidioribus, penetrantissimis, inseparabilius constans, non tantum una qualitate cuncta solvebat, sed & altera reunionem impediabat ; cum particula hujus rigidiores, in actu continua, sese flectere, saliaq; divisa in alienam naturam combinare non valuerint.

Spiritus vero salis Armoniaci urinosus, salibus istis volatilibus consimilis, exque fixis productus, illa non modo quieta reliquit, sed & hæc ut gremium suum amplexus.

Hinc

Hinc longe alia calculorum horum generandi ratio & locus quam eorum qui abs renibus excluduntur; cum hi e particulis seri rigidioribus, vel ad pororum renalium relationem crassioribus, sensim obhærentibus eosq; oblitterantibus contexantur; lubrica quidem aqua flexibilibus particulis decidat, salia vero sero innatantia volatilia insensibiliter reticulo huic implicentur, tandemq; in lapideam duritiem accrescant; Quod prius communi experientia constans exhibet senes, quibus crassiores humores, minusq; meabiles meatus contingunt, in hunc affectum valde pronos; Posterius distillatione firmatur; etenim imminuendo ejusmodi calculos donec collum angustum retortæ ingrediantur, prodit spiritus urinosus cum sale volatili multo & aliquo oleo, remanentq; in fundo retortæ non commota figura lapidum, quæ in cineres commovendo decidunt, quæq; vero rursus affuso distillato liquore in calculos conjunguntur: ex quibus salis volatilis copia & implicandi modus in his optime constant.

Qualiter vero & ubi in agra nostra generentur lapilli & tephri Tartarei (ea in vivis) vix esset hujus loci & temporis divinare, nisi rationi aliquid concedendum foret.

Vesicas sub epidermide limpidò sero flagrant, ibiq; ob impeditam cuticulæ transpirationem obstructæq; glandularum subcutanearum poros, denegantes refluxum collecto, sanguini pellenti non vero quieto ortum debent; cum hic a tempore quo coagulari visus est, nusquam ampullas suscitavit, & secus motui contrarium esset: Mordax vero lancinansq; humoris qualitas atq; inspissatio singularis, acidi in corpore prædominantis argumentum; cujus rimari naturam difficile, cum levissima additione vel detractiōe motuve, humores alterentur, ut ex chylo sanguis, ex sero lymphæ, ex aqua forti regia generentur, aliisve naturalibus cernere evidens est. Qui humores in receptaculis suis glandulosis, ut locis natalitiis, variè & perversim alterati tantas coagulationes efficient, cum stagnantes exhalato Alkali spirituosò inspissantur & acescunt; haud secus ac analogum sanguini vinum, quod evanidis sulphuris particulis quibuscum acidæ incorporatæ hærebant, relictis his, in aorem vertitur: Et certe dulcis acidiq; ratio non alia est, quam diversimoda major minorve acutarum partium cum aliis commixtio, actusq;

retardatio, ut in saccharo, melle, &c. Hinc sanguis, etsi tandem inspissatus, tamen dulcis linguae occurrit: immo pro tactus ratione magis minusq; feriunt, parva inter titillationem & dolorem distantia.

Merito ergo glandula præprimis inferioris ventris, seri lymphatici (vel pituitæ in hoc acida) receptacula & ergastula, in vitio occurrunt, quo humor, jam heterogeneus ductibus suis, haud exoneratus, atq; e pancreate in duodenum longo intervallo non solutus, acidior evasit: Hinc prior hisce præ utero attribuenda mali labe, (cum naturaliter absq; imprægnatione, mensium suppressio ante Annos senectutis, nulla contingat) quæ in hoc corpore primos effectus latentes ederit, unde restagnans sanguis majorem corruptionem, majoresq; turbas fovebat; non enim subordinatæ causæ pugnant.

Subita vero vesicarum evanescencia ad remedia resolventia volatilia commode refertur, quibus obstructions universi referare nitebamur; factum unde ut una cum meatibus glandulosis patefactis non modo refluxus resoluti humori datus, sed & magnum pituitæ receptaculum pancreas, impetu in intestina & abhinc massam chyli viscosam, indeq; sanguinis universam, humorem contentum acidum effuderit, sicq; diathesin pravam hucusq; continuatam induxerit: Qui Chylus juxta principia sua alius vix statui potest, ægra adhuc in sanis magno aquarum potui ad juvenilem viscerum æstuantium calorem supprimendum dedita; Aquis etsi in hac urbe saluberrimis in subjecto capaci evidentem causam non detrahimus, ex qua consequens obstructio ductuum glandularumve concinnari potuit: Quantum vero vel an contribuat bilis in petrificatione hac vix invenire est, cum hæc aliter ac nostri calculi sale lixivioso redundet.

Hinc ventriculus, intestina, glandula primarij generationis loci, quamvis & in vesica secundario procreentur: Latex quippe urinosus primæ digestionis vitio ita inquinatus, secundæ excrementum, multo acido, saleq; & crasso phlegmate imbutus, in vesica stagnans, in coagulum invicem accedentibus particulis aptis coarctat; unde & mucus & calculi absque alterius rei accessu vel dissipationis ope.

Qua-

Quatenus vero ante, silices exiguos variaque camenta evomuerit, cum abhinc vomitu nihil excreverit, causa delitescit in corpore; aquarum tamen pro ratione subjecti occupati diversa, diversa est lapides producendi & incorporandi vis.

Pondus specimina probant, non enim desistente agendi vi in subiecto disposito, effectus continuantur, ut decem hactenus libras superarint.

Aliena a podagricorum tophis substantia primos, ventriculo excretos, rarioris compactura, Aer non ut salia humectando, cum minima haberent, in fluorem, sed rariores minusq; firmiter implexos angulos movendo insensibiliter contritos in pollinem redegit; quemadmodum in vitriolo albo, lignis corruptis exsuccis, aliisque ab aere contingere videmus; contra vero vini spiritus rectificatus raros poros facillime intrans, nec aeris instar vibrans, fibrillas quietas sustinebat.

Motus naturam esse renitente objecto circulare vermiculariter at retrograde in nostro subiecto, patet, majoribus lapillis ad angustam portam intra exitum Ilii & principium Coli circa Cæcum obherentibus, retractis orbicularibus musculosis intestinorum fibris, peristaltici motus inversionem contigisse, causam vero tam violentam ut calculum, facile valvulam aut ineptam everfisse, aut plane dirupisse.

Hoc ostio patente, quid ni stimulata intestina Clysmata sursum absque excrementis durissimis rejecerint? cum scybala videamus in colicis adeo indurata cellulis inhaerere, tandemq; ad alvum descendere, ut vix coctione solvi, multoque minus clysmate dilui possint; Æque quidem mirum hæc contigisse & etiamnum contingere infartibus ductibus crassioribus lapillis, verum ad horum figuræ varietatem spectantes, eos non ad intestinorum cavitatem conformari, sed ubiq; lateraliter, immo in aliquibus per ipsa quibus perforantur foramina chylo descensum & clysmatibus ascensum concedere.

Urinosi laticis colorem varie immutari, substantiamve alterari pro accedentis vel deficientis ratione quemvis dies docet; Caruleæ vero pellucida contra naturæ ordinem succedentis cum tempore alia est perquirenda ratio; illis enim magis minusve bile saturatis in-

tenditur vel remittitur tinctura, aut admixtis variis heterogeneis, vel spiritibus exhalatis incrassatur, inque opacam & virulentam vertitur urina.

Cujus collectæ excretionem impediēbat mucus in vesica, ejus col- lum glutinans, tantam vero octo librarum quantitatem vesica capere incapax, nisi non naturalem extensionem ei concedamus; qualem in puella sub finem anni septuagesimi secundi Johanna Heuschleria observavi; ad quam ut asciticam accersitus, quærenti causas, obtigit inflammatio colli vesicæ, Anodyna & post Cathete- rem applicare jussi, unde incredibilis lotij quantitas libras novem superans, subsidente ventre, continuo fluxit, ipsaque convuluit; Urinas vero non tam in vesica quam renibus, vasisque cæteris re- dundare superius exemplum Dn. I. W. declarat.

Evenire unde potuit ut excedens hujus laticis urinosi quantitas apertis Cæliacæ ostioli in cavitatem ventriculi exudarit; verum propius observantibus constat, urina non redundante ejusmodi fieri vasuationem, plurimum puram, aliquando vero quibusdam chyli ciborumq; particulis mixtam; Nec si quis antecedentem historiam serio examinabit, ne quicquam excretiones ante primas agræ in- gestum, multo minus huc usque datum intelliget, quod urinosum saporem induere valuerit; Nec latex semper redundans vasa sanguifera eructare cogit: Inde ex ipsius rei contingentibus veris aliquid contra naturæ leges in hoc corpore contingere, conjicere licet, forsāque continuatæ calculorum generationis aliqua causa petenda, cum ventriculus nova saburra perversoq; fermento hu- morum quotidie tentetur; secus jam jam remediis alteratus esset: Memor quidem exempli quod mihi contigit, Anno 1677. in Eva Zuberæ annorum quadraginta civæ urbis hujus, quæ enixu partus violento, vesicæ urina distenta, fatus exitu valide compressa, hæc; violenta causa aperto uracho, urina per umbilicum integro puerperio majorem portionem exoneravit, demum consolidato hoc, naturaliter fluxit; Ast a naturalibus & manifestis ad non natu- ralia occulta hætenus concludendum non est.

Abstinentiæ thema Lentulus noster ad divum Jacobum pri- mum, Regem Angliæ Potentissimum pertractavit, ignota tum transpirationis hujusq; principii circulationis causa varie ratioci-
natus

natus; sed ad hanc reflectentes, hominem respirare adq; substantiæ deperditæ restitutionem refici, Ars statica docet plus insensibiliter e corpore excerni transpirando quam per omnes excretorias vias sensibiliter excludi

Ut vir robustus in actione permanens octo librarum, potu citq; singulis diebus saturatus, tres tantum vel in summum quatuor lib. manifestis in excrementis deponat, facta tamen digestionè amplius non ponderet quam cibum ante sumtum: Hinc coctionum energia omnia imminui inq; spiritus tandem resolvi, & transpirationis, in solutione morborum insensibili & hecticorum devorata substantia, veritas consistit; qua non ob epidermidis constipationem procedente, non opus erat refectione; secus aer inspirari ad spirituum vitalium refectionem debuit, ut expirari possit, sicq; in motu manere; qui ipse aer inspiratus, incrassatus, in vasis in serum versus, urinandi materiam tempore abstinentiæ commodam præbuit, ut hydropicos sæpius cernimus solo aere, aquosis suis particulis, in crescere.

Hæc sunt, Excellentissimi Domini, quæ olim desiderastis, exigua quidem, nisi favore vestro, digna ad majora videantur. Plurima horum Calculorum specimina doctis præclaris amicisq; viris in rei testimonium mittere volumus, ut si aliquid cum tempore observari velint, hortari dignentur; Inclyti enim Senatus nostri Amplissimi mandato, pro Clementia sua in miseros, ægra nostra publico loco sustentatur et observatur, cautumq; est ne mortua ante exactam eviscerationem sepeliatur, quo publico ex ipsius laudatissimo desiderio aliquid boni redundare possit.

Dabam Bernæ in
Helvetiis ulti-
ma Feb. 1686.

Sigism. Konig. M. D.
Incl. Rpl. Ph.

Horum Calculorum specimina duo una misit Cl. D. Konig, quorum figuras iuxta magnitudine accurate exhibent Fig. 3 & 4. R. Societas rei novitate permota, voluit eos spagyrico examini subicere, administrante Chymico excellentissimo D. D. Slareo. Eventum e Transactione proxime edenda scies.

A Discourse of the Rule of the decrease of the hight of the Mercury in the Barometer, according as places are Elevated above the Surface of the Earth, with an attempt to discover the true reason of the Rising and Falling of the Mercury, upon change of Weather.

By EDM. HALLET.

THe Elastick property of the *Air* have been long since made out, by Experiments before the *R. Society* and elce where; and the Resistance of its Spring is found to be nearly equal to the Weight or Force that compresses it; as also, that the spaces the same *Air* occupies, under differing Pressures are Reciprocally as those Pressures: it has been shown likewise by undoubted Experiment, that the Specific Gravity of the *Air*, near the Earths Surface to that of Water, was once as 1 to 840, again as 1 to 852, and a third time, in a very large Vessell holding ten Gallons, as 1 to 860; all which, considering the difficulty of the Experiment agree well enough, the *Mercury* standing at all those times about 29 *Inches* $\frac{3}{4}$; but by reason twas Summer Weather and consequently the *Air* rarified when all these were tryed, we may without sensible Errour say in round Numbers, that the *Barometer* standing at 30 *Inches*, and in a mean state of Heat and Cold, the Specific Gravity of the *Air* to Water, is as 1 to 800: By the like Tryals the weight of *Mercury* to Water, is as 13 $\frac{1}{2}$ to 1, or very near it, so that the weight of *Mercury* to *Air*, is as 10800 to 1, and a Cylinder of *Air* of 10800 *Inches* or 900 *Feet*, is equal to an *Inch* of *Mercury*, and were the *Air* of an equal density like Water, the whole *Atmosphère* would be no more than 5, 1 *Miles* high, and in the Ascent of every 900 *feet* the *Barometer* would sink an *Inch*. But the expansion of the *Air* encreasing in the same proportion as the incumbent weight of the *Atmosphère* decreases, that is as the *Mercury* in the *Barometer* sinks, the upper parts of the *Air* are much more rarified than the lower,
and

and each space answering to an *Inch* of *Quicksilver* grows greater and greater, so that the *Atmosphere* must be extended to a much greater height. Now upon these principles, to determine the height of the *Mercury* at any assigned height in the *Air*, and *e contra* having the height of the *Mercury* given, to find the height of the place where the *Barometer* stands, are Problems not more difficult than Curious; and which I thus resolve.

The expansions of the *Air* being Reciprocally as the heights of the *Mercury*, it is evident, that by the help of the Curve of the *Hyperbola* and its *Asymptotes* the said expansions may be expounded to any given height of the *Mercury*: For by the 65th prop. lib. 2. *Conic. Mydorgii*, the Rectangles AB CE, AKGE, ALDE, &c. (in fig. 5.) are always equal, and consequently the sides CB, GK, LD, &c. are reciprocally as the sides, AB, AK, AL, &c. If then the lines AB, AK, AL, be supposed equal to the heights of the *Mercury*, or the pressures of the *Atmosphere*, the lines CB, KG, LD, answering thereto, will be as the Expansions of the *Air* under those pressures; or the bulks that the same quantity of *Air* will occupy; which Expansions being taken infinitely many, and infinitely little, (according to the method of Indivisibles) their summe will give the spaces of *Air* between the several heights of the *Barometer*; that is to say the summe of all the lines between CB and KG, or the Area CBKG, will be proportioned to the distance or space intercepted between the Levels of two places in the *Air*, where the *Mercury* would stand at the heights represented by the lines AB, AK; so then the spaces of *Air* answering to equal parts of *Mercury* in the *Barometer*, are as the Areas CBKG, GKL D, DLFM, &c. These Areas again are, by the Demonstration of *Gregory* of *St. Vincent*, proportionate to the *Logarithms* of the numbers expressing the *Rationes* of AK to AB, of AL to AK, of AM to AL, &c. So then by the common Table of *Logarithms*, the height of any place in the *Atmosphere*, having any assigned height of the *Mercury*, may most

easi-

easily be found: For the line CB in the *Hyberbola*, whereof the *Areas* design the *Tabular Logarithms*, being 0, 0144765; t'will be, as 0, 0144765, to the difference of the *Logarithms* of 30, and any other lesser Number, so 900 feet or the space answering to an Inch of *Mercury*, if the *Air* were equally prest with 30 Inches of *Mercury* and every where alike, to the hight of the *Barometer* in the *Air*, where it will stand at that lesser Number of Inches: And by the converse of this proportion may the hight of the *Mercury* be found, having the Altitude of the place given. From these Rules I derived the following Tables.

A Table shewing the Altitude, to given hights of the Mercury.

<i>Inch.</i>	<i>Feet.</i>
30. — — — — —	0
29. — — — — —	915.
28. — — — — —	1862.
27. — — — — —	2844.
26. — — — — —	3863.
25. — — — — —	4922.
20. — — — — —	10947.
15. — — — — —	18715.
10. — — — — —	29662.
5. — — — — —	48378.
1. — — — — —	91831.
0, 5. — — — — —	110547.
0, 25. — — — — —	129262.
0, 1. 29 mil. or	154000.
0, 01. 41 mil.	216169.
0, 001. 53 mil.	278338.

A Table shewing the hights of the Mercury, at given Altitudes.

<i>Feet.</i>	<i>Inch.</i>
0 — — — — —	30, 00.
1000. — — — — —	28, 91.
2000. — — — — —	27, 86.
3000 — — — — —	26, 85.
4000 — — — — —	25, 87.
5000 feet — — — — —	24, 93.
1 mile — — — — —	24, 67.
2 — — — — —	20, 29.
3 — — — — —	16, 68.
4 — — — — —	13, 72.
5 — — — — —	11, 28.
10 — — — — —	4, 24.
15 — — — — —	1, 60.
20 — — — — —	0, 95.
25 — — — — —	0, 23.
30 — — — — —	0, 08.
40 — — — — —	0, 012.

Upon these Suppositions it appears, that at the hight of 41 miles, the *Air* is so rarified, as to take up 3000 times the space it occupies here, and at 53 miles high, it would be expanded above 30000 times; but tis probable that the utmost power of its spring cannot exert it self, to so great an extension, and that no part of the *Atmosphere* reaches above 45 miles from the surface of the Earth.

This seems confirmed from the Observations of the *Crepusculum*, which is observed commonly to begin and end when the Sunn is about 18 degrees below the *Horizon*; for supposing the *Air* to reflect light from its most rarified parts, and that as long as the Sun illuminates any of its *Atoms*, they are visible to an Eye not intercepted by the Curvity of the Earth, it will follow from Fig. 6. that the proportion of the hight of the whole *Air*, to the Semidiameter of the Earth, is much about, as 1 to 90, or as the excess of the *Secant* of about $8\frac{1}{2}$ degrees to *Radius*: For if E be the Eye of the Observer, S a place where the Sun sets at the end of twilight in E, and the Arch ECS, or TCA be found 18 degrees, the excess of the *Secant* of half thereof ECH, would be the hight of the *Air* viz. GH: But the beam of the Sun ASH, and the visual Ray EH do each of them suffer a Refraction of about 32 or 33 minutes, whereby being bent inwards from H towards G, the hight of the *Air* need not be so great as if they went streight; and having from the Angle ECS taken the double *Refraction* of the *Horizontal Ray*, the half of the remainder will be $8\frac{1}{2}$ degrees *circiter*; whose *Secant* being 10111 it follows that as 10000 to 111, so the Semidiameter of of the Earth supposed 4000 miles, to 44, 4 miles; which will be the hight of the whole *Air*, if the places E, S, whose Visible portions of the *Atmosphere* ERZH, and SHKB just touch one the other, be 18 degrees assunder.

At this height the *Air* is expanded into above 3000 times the space it occupies here, and we have seen the experience of Condensing it into the 60th part of the same space, so that it should seem, that the *Air* is a substance capable

of being compressed into the 180000th part of the space it would naturally take up, when free from pressure; Now what texture or composition of parts shall be capable of this great expansion and contraction, seems a very hard question; and which, I suppose, is scarce sufficiently accounted for, by the comparing it to Wool, Cotton, and the like springy bodies.

Hitherto I have only considered the *Air* and *Atmosphere*, as one unaltered body, as having constantly at the Earth's surface the 800th part of the weight of Water, and being capable of rarefaction and condensation *in infinitum*; neither of which *Hypotheses* are rigidly true: for here in *England* 'tis notoriously known, that the weight of the whole *Atmosphere* is various, being counterpoised sometimes by $28\frac{1}{2}$ inches of *Mercury*, and at other times by no less than 30 $\frac{1}{2}$, so that the under parts being pressed by about a 15th part, less weight, the *specifick* gravity of the *Air* upon that score will sometimes be a 15th part lighter than another; Besides heat and cold does very considerably dilate and contract the *Air*, and consequently alter its gravity, to which add the mixture of *effluvia* or steams rising from almost all Bodies, which assimilating into the form of *Air* are kept suspended therein, as Salts dissolved in Liquors or Mettles in corroding *Menstrua*, which bodies being all of them very much Heavier than *Air*, their particles by their admixture must needs encrease the weight of that *Air* they lie incorporated withal, after the same manner as melted Salts do augment the *Specifick Gravity* of Water. The other consideration is that the Rarefaction and Condensation of the *Air* is not precisely according to the proportion here laid down, for tho experiment very nearly agrees thereto, as may be seen in the 58th Chapter of Mr. *Hook's Micrographie*, yet are the Condensations not possible beyond certain degrees, for being compressed into an 800th part of the space it takes up here, its consistence would be equally dense with that of Water, which yeilds not to any force whatsoever, as hath been found

found by several experiments tryed here, and at *Florence*, by the *Academia del Cimento*. Nor can the Rarefaction proceed *in infinitum*; for supposing the Spring whereby it dilates it self, occasioned by what texture of parts you please, yet must there be a determinate magnitude of the natural state of each Particle, as we see it is in Wooll and the like, whose bodies being compressable into a very small space, have yet a determinate bulk which they cannot exceed, when freed from all manner of pressure.

These objections being true do disturb the Geometrical accuracy of these conclusions, drawn from the specifick gravity of the *Air* observed at any time; but the Method here shewn will compute by a like calculation, the hights of the *Quicksilver*, and the Rarefactions of the *Air* from any assigned hight of the *Barometer* at the Earths Surface, and any specifick Gravity given. As to the Condensation and Rarefaction by heat and cold, and the various mixture of Aqueous and other Vapours, these two objections seem generally to compensate each other, for when the *Air* is rarified by heat the Vapours are raised most copiously, so that tho' the *Air* properly so called, be expanded and consequently lighter, yet the *interstices* thereof being crouded full of Vapours of much heavier matters, bulk for bulk the weight of the *Compositum* may continue much the same; at least a most Curious experiment made by the Ingenious Mr. *John Caswell* of *Oxford* upon the top of *Snowdon* hill in *Caernarvan-Sheir*, seems to prove that the first Inches of *Mercury* have their portions of *Air* near enough to what I now determine; for the hight of the hill being 1240 yards or very near it, he found the *Mercury* to have subsided to 25,6 inch. or 4 inch. below the mean Altitude thereof at the level of the Sea, (which is a greater difference than has been found in any of our former Experiments,) and the space answering to 4 inch. by my calculation should be 1288 yards; and it agrees as well with the Observations in the Appendix to Mr. *Pascall's* Book, *del' Equilibre des Liqueurs*, made on the high hill in

Auvergne, call'd *le puy de Domme*. So that the Rarefaction and Vapours seem not to have altered considerably, the Gravity of the under parts of the *Air*; and much above the hight where these Experiments were made, do few Vapours ascend, and the cold is such that the Snow lies continually, so that for the more elevated parts of the Sphere of *Air* there is much less reason to doubt.

But now we have had occasion to mention the difference there is between the hight of the *Mercury* at one time, from the hight thereof at another, it may not be unacceptable to offer at some reasons for the said difference, which, at least to my self, seem to have some appearance of truth; *first* then tis undoubtedly demonstrable that the hight of the Cylinder of *Mercury*, is equal to the weight of the whole incumbent *Air*, and consequently that that whole is sometimes a fifteenth more than at other times, which cannot otherwise be, but by the access of new matter when tis heavy, and its diminution when tis light; that *Hypothesis* therefore that shews how the *Air* shall be encreased or diminished, in any particular place, will give a reason for the greater and lesser hight of the *Mercury* in the *Baroscope*: but to direct us in the choice of the several causes, which may be assigned for the encrease and decrease of the *Air*, twill not be unnecessary to enumerate some of the principle observations made upon the *Barometer*, most whereof are sufficiently known already to all those that are curious in these matters.

The *first* is, that in calm weather when the *Air* is enclined to Rain, the *Mercury* is commonly low.

2. That in Serene good settled weather the *Mercury* is generally high.

3. That upon very great Winds tho' they be not accompanied with Rain the *Mercury* sinks lowest of all, with relation to the point of the Compass the Wind blows upon.

4. That *ceteris paribus* the greatest hights of the *Mercury* are found upon Easterly and North-easterly winds.

5. That in calm frosty weather the *Mercury* generally stands high.

6. That after very great stormes of Wind, when the *Quicksilver* has been low, it generally rises again very fast.

7. That the more Northerly places have greater alterations of the *Baroscope* than the more Southerly.

8. That within the *Tropicks* and near them, those accounts we have had from others, and my own Observation at *St. Helena* make very little or no variation of the height of the *Mercury* in all weathers: Now that Theory that can well account for all these Appearances, will in all probability approach nearer the true Cause of the *Barometers* variations, than any thing hitherto offered; and such an one I am bold to believe, is that which I here lay down, with submission to better Judgments.

I conceive that the principal Cause of the rise and fall of the *Mercury*, is from the Variable Winds, which are found in the *Temperate Zones*, and whose great unconstancy here in *England* is most notorious: I shall not at present inquire into the Cause of its uncertainty, but the matter of Fact being most undoubted, the Legitimate Consequences thereof must be allowed me; let it proceed from what it will.

A Second Cause is the uncertain Exhalation and Precipitation of the Vapours, lodging in the *Air*, whereby it comes to be at one time much more crouded, than at another, and consequently heavier; but this latter in a great measure depends upon the former. Now from these Principles, I shall endeavour to Explicate the several *Phanomena* of the *Barometer*, taking them in the same Order, I layd them down.

I. *Why in Calm Weather, the Air being inclined to Rain, the Mercury is commonly low?* I Answer that, the *Mercury's* being low, enclines it to Rain, for the *Air* being light, the Vapours are no longer supported thereby, being become specifically heavier than the *Medium* wherein they floated; so that they descend towards the Earth, and in their fall meeting with other aqueous Particles, they incorporate together and forme little drops of Rain; but the *Mercurys* being

ing at one time lower than at another, is the effect of two contrary Winds blowing *from* the place where the *Barometer* stands; whereby the *Air* of that place is carried both ways from it, and consequently the incumbent Cylinder of *Air* is diminished, and accordingly the *Mercury* sinks; as for instance, if in the *German Ocean* it should blow a gale of *Westerly Wind*, and at the same time an *Easterly Wind* in the *Irish Sea*; or if in *France* it should blow a *Southerly Wind*, and in *Scotland* a *Northern*; it must be granted me that that part of the *Atmosphere* impendent over *England*, would thereby be exhausted and attenuated, and the *Mercury* would subside, and the Vapours which before floated in those parts of the *Air* of equal Gravity with themselves, would sink to the Earth.

2. *Why in Serene good settled Weather the Mercury is generally high?* To this I answer, That the greater height of the *Barometer*, is occasioned by two contrary Winds blowing *towards* the place of Observation, whereby the *Air* of other places is brought thither and accumulated; so that the incumbent Cylinder of *Air* being encreased both in height and weight, the *Mercury* pressed thereby must needs rise and stand high, as long as the Winds continue so to blow; and then the *Air* being specifically heavier, the Vapours are better kept suspended, so that they have no inclination to *Præcipitate* and fall down in drops, which is the reason of the *Serene good Weather*, which attends the greater heights of the *Mercury*.

3. *Why upon very great Winds or Storms though accompanied with no Rain, the Mercury sinks lowest of all, with relation to the point of the Compass upon which the Wind blows.* This is caused by the very rapid motion of the *Air* in these Storms; for the Tract or Region of the Earths Surface wherein these Winds rage, not extending all round the Globe, that stagnant *Air* which is left behind, as likewise that on the sides, cannot come in so fast as to supply the Evacuation made by so swift a Current, so that the *Air* must necessarily be attenu-

nuated when & where the said Winds continue to blow, and that more or less according to their Violence ; Add to which that the *Horizontal* motion of the *Air* being so quick as it is, may in all probability take off some part of the perpendicular pressure thereof : and the great agitation of its particles, is the reason why the Vapours are dissipated and do not condense into drops, so as to form Rain, otherwise the natural consequence of the *Airs* rarefaction.

4. *Why cæteris paribus the Mercury stands highest upon an Easterly or North-easterly Wind.* This happens because that in the great *Atlantick Ocean* on this side the 35th degree of North Latitude, the Westerly and South-Westerly Winds, blow almost always *Trade*, so that whenever here the Wind comes up at East and North-East, 'tis sure to be checked by a contrary Gale, as soon as it reaches the *Ocean* ; wherefore according to what is made out in our second Remark, the Air must needs be heaped over this *Island* ; and consequently the *Mercury* must stand high, as often as these Winds blow. This holds true in this Country, but is not a general rule for others, where the Winds are under different Circumstances : and I have sometimes seen the *Mercury* here as low as 29 Inches, upon an Easterly Wind, but then it blew exceeding hard, and so comes to be accounted for by what was observed upon the 3^d. Remark.

5. *Why in calm frosty weather the Mercury generally stands high.* The cause hereof is, as I conceive that it seldom freezes but when the Winds came out of the Northern and North-Eastern Quarters, or at least, unless those Winds blow at no great distance off, for the Northern parts of *Germany*, *Denmark*, *Sweden*, *Norway*, and all that tract from whence North-Eastern Winds come, are subject to almost continual Frost all the Winter ; & thereby the lower Air is very much condensed, and in that State is brought hitherwards by those Winds, and being accumulated by the Opposition of the Westerly Wind blowing in the Ocean, the *Mercury* must needs

needs be prest to a more than ordinary hight, and as a concurring cause, the shrinking of the lower parts of the *Air* into lesser room by cold, must needs cause a descent of the upper parts of the *Atmosphere* to reduce the cavity made by this contraction to an *Æquilibrium*.

6. *Why after very great Storms of Wind, when the Mercury has been very low, it generally rises again very fast.* This I have frequently observed, and once found it risen an Inch and half in less than six hours, after a long continued Storm of South-West Wind. This seems to be occasioned by the sudden accession of new *Air* to supply the great Evacuation which such continued Storms make thereof, in those places where they happen (as in the third remark) and by the Recoile of the *Air*, after the force ceases that impell'd it; and the reason why the *Mercury* rises so fast, is because the *Air* being very much rarified beyond its mean density, the neighbouring *Air* runs in the more swiftly to bring it to an *Æquilibrium*, as we see water runs the faster for having a great declivity.

7. *Why in more Northerly Places the Variations of the Baroscope are greater than in the more Southerly;* The truth of the matter of fact is proved from observations made at *Clermont* and *Paris* compared with others, made at *Stokholm*, as may be seen in the *Appendix* to Mr. *Pascals* book before cited. The reason I conjecture to be, that the more Northerly parts have usually greater Storms of Wind than the more Southerly, whereby the *Mercury* should sink lower, in that extream; and then the Northerly Winds bringing the Condensed and Ponderous *Air* from the Neighbourhood of the *Pole*, and that again being checked by a Southerly Wind, at no great distance, and so heaped, must of necessity make the *Mercury* in such case stand higher, in the other extream.

8. And Lastly, *Why near the Equinoctial as at Barbadoes and St. Helena, there is very little or no Variation of the height of the Barometer.* This Remark above all others, Confirms the *Hypothesis* of the Variable Winds being the cause of these

these Variations of the height of the *Mercury*, for in the places above named, there is always an easy Gale of Wind blowing nearly upon the same point, *viz*, E.N.E. at *Barbadoes* and E.S.E. at *St. Helena*, so that there being no contrary Currents of the *Air*, to exhaust or accumulate it, the *Atmosphere* continues much in the same State: However upon *Hurricanes*, the most Violent of Storms, the *Mercury* has been observed very low, but this is but for once in two or three years, and it soon recovers its settled state of about $29\frac{1}{2}$ Inches. I doubt not but the same thing is in the East Coast of *Africa* and in *India*, where the Monsoons or Winds are Trade for half the year one way, and half the year another; only tis probable, that there may something worth noting happen, about the times of the Change or shifting of the Winds, which might be obtained if any body had the curiosity to keep the *Barometer* at our Factories in *India*.

I doubt not but this Doctrine will find some Opposers, and that one principal Objection will be, That I suppose the *Air* sometimes to move *from* those parts where it is already evacuated below the *Equilibrium*, and sometimes again *towards* those parts, where it is condensed and crowded above the mean state, which may be thought contradictory to the laws of *Statics* and the rules of the *Equilibrium* of Fluids. But those that shall consider how, when once an *Impetus* is given to a fluid body, it is capable of mounting above its level, and checking others that have a contrary tendency to descend by their own gravity, will no longer regard this as a material Obstacle; but will rather conclude, that the Great *Analogy* there is between the rising and falling of the Water upon the *Flux* and *Reflux* of the *Sea*, and this of the accumulating and extenuating the *Air*, is a great Argument for the truth of this *Hypothesis*. For as the Sea, over against the Coast of *Essex*, rises and swells by the meeting of the two contrary Tides of *Flood*, whereof the one comes from the S.W. along the Chanel of *England*, and the other from

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the *North*;) and on the contrary sinks below its level upon the retreat of the *Water* both ways, in the Tide of *Ebb*; so it is very probable, that the *Air* may *ebb* and *flow*, after the same manner; but by reason of the diversity of Causes, whereby the *Air* may be set in moving, the times of these *fluxes* and *refluxes* thereof, are purely casual and not reducible to any Rule, as are the Motions of the Sea, depending wholly upon the regular course of the *Moon*. The next *Transaction* shall give an Historical Relation of those *Winds* which are found to have any thing of Constancy, and shall endeavour to assign the Causes thereof.

An Account of two Books, (1.) *A Free Enquiry into the Vulgarly received Notion of Nature*, by the Honourable R. Boyle, Esq; Printed by J. Taylor at the Globe in St. Paul's-Church-Yard, Anno 1686. 8vo.

TIS not without reason, that the renowned Author of this Treatise wonders that none have written concerning *Nature* herself, and yet so many have so largely treated of the Works of *Nature*. But this will seem less strange to him that considers for how many Ages the whole Learned World has been devoted to the *Peripatetick* Principles of *Matter* and *Form*, and with how blind an obedience the Doctrine of *Aristotle* hath been universally received and maintained; For the vulgar Notion of *Nature*, concurring with the *Peripatetick*, having been generally admitted, all men thought it unsafe to oppugn the opinion of the multitude, and at the same time to call in question the authority of those reputed for Learning; subjecting their own judgments, by a servile resignation unworthy the name of a Philosopher to the Dogmes of others. This seems to be the chief, if not the only cause of the propagation
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tion of Errours, as well in *Philosophy*, as in other matters of more concern, as Religion and Divine Worship: but these not being the present scope of our Author, he in this excellent and learned Essay shews, that in Philosophical Inquiries, the vulgarly received Notion of *Nature* hath given great occasion of Errour, being admitted without a due examination.

The whole is divided into eight Sections, the scope of which is briefly as follows:

In the first Section, after having premised something of the manner of conception in the rational soul, our Author, with his usual acuteness, answers two Objections, shewing, that it is neither ungrateful nor blameable, for a Son of *Nature* to oppugn *Nature*, after this manner: likewise, that there is sometimes a necessity to recede from the common opinion of men.

The second Section reckons up the several vulgar acceptations of the word *Nature*, and then substitutes in their places, other Words and Expressions more suitable to the true notion of *Nature*.

The third, examines the *Aristotelian* definition of *Nature*, and proves it obscure, intricate and affording no light, whereby to explain other things; which done, our Noble Author sets forth the reason why he endeavours to avoid the frequent use of this word *Nature*.

The fourth Section, in the first place, examines several Axioms concerning *Nature*, whereby she is described after the vulgar apprehension; and then lays down a much better description of her, after a most learned dissertation concerning the several forms of speech relating thereto: Here our Author distinguishes *Nature* into general, which he calls *Cosmical Mechanism*, and particular, which he names *Individual Mechanism*. In the conclusion is shewn the original of *Polytheism*, and how *Nature* came to be a made Goddess by the Antients.

The fifth proposes the Reasons whereby our Author was perswaded to reject the received Notion of *Nature* ; as first, that such a Notion has no sufficient proof to establish it ; that it is unnecessary, obscure and unintelligible, that it is dangerous to Religion in general, and consequently to the Christian, and that it is contradicted by the daily observation of several *Phænomena*, &c.

The sixth discusses the Arguments in behalf of *Nature*, drawn from the common consent of Mankind ; from the endeavour observable in Bodies to maintain their Natural state ; from the distinction of Motion into *Natural* and *Violent* ; from the *Crisis* of Diseases, &c.

The seventh Section, with the usual clearness and subtilty of our Author, expounds, according to the Doctrine here laid down, the several received Axioms or Attributes of *Nature* ; among others these two, *Natura Vacuum Horret*, and *Natura est Morborum Medicatrix*, are largely and most accurately handled.

The eighth and last Section shews, that *Nature*, according to the vulgar Acceptation, is not a real, but an imaginary Being ; and conformable to the Doctrine of this Treatise, a new and peculiar *Hypothesis* of Divine Providence is proposed ; In the end, the Advantages and Utility of the whole are briefly touched upon.

Traite du Mouvement des eaux et des autres Corps fluides par feu Mr. Mariotte, A Paris. An. 1686. Octavo.

THIS Book having been designed by the Ingenious Mr. *Mariotte*, and by him in a great Measure completed at his Death ; has had the good Fortune to receive the last hand from Mr. *De la Hire*, whose great abilities in the Mathematicks, are too well known to need mention in this place. The whole is divided into five Parts, and each Part again into Discourses or Chapters ; the first Part contains 3 Discourses, whereof the first is about the several Properties of fluid Bodies, as their Glaciation, Evaporation, Dilatation upon Heat, and admission of the Air into their Pores, &c. The 2d. is about the Original of Fountains, which he deduces from the Rains that fall, and sink into the Earth, till they meet with a Clayey or Rocky Soyl, which being not able to pass, they run alongst, till they find their way out into the Air, where they become Fountains. And to prove the quantity of Rain Water, sufficient to furnish the Rivers, he shews by Experiment that there falls in the Countries about the Fountains of the *Seine*, at least 7 times as much Water, as the said River evacuates. The 3d. is about the Origine and Cause of Winds, of which he assigns 3 general and 4 particular Causes, the first of the general, is the Diurnal Motion of the Earth ; the second is the Condensation and Rarefaction of the Air, caused by the heat of the Sunn. The 3d. is from the Moons respect to her *Apogaeon* or *Perigaeon*, whereby she sometimes rises from, other times descends towards the Earth. The particular causes are, 1st. the extraordinary rising of the Vapours and Exhalations out of certain places of the Earth.

2d.

2d. The fall of great Rains and Hails. 3d. The great Quantity of nitrous and Sulphureous Exhalations in Earthquakes. 4th. The Soudain melting of Snow in the High Mountains; and from these several causes combined, he thinks he can account for all the Phænomena of Winds, particularly the *Trade Winds* between the *Tropicks*, called by him *Vents Ali-zez*, but in so doing he seems not sufficiently informed in their History: In this Discourse are several curious Remarques, and Observations touching the Course, Propagation, &c. of the Wind.

The second Part Treats of the *Æquilibrium* of Fluids; the first Discourse demonstrating from the Principles of Mechanicks, how Fluids counterpoise one anothers weight, and giving the Rules of the Doctrine of floating Bodies: The second Discourse shews the Nature of the *Elasticity* of Air and Flame, and how their Spring is counterpois'd by weight. The third Discourse Treats of the Equipollence of a Fluid Body to a stroak or shock; shewing the Rules of the force of *Jets d'eau*, from several hights of the Reservoir, and differing Diameters of the Bore of the Pipe; giving in the end an account of the comparative force of Wind and Water-mills, with the manner of computing them; together with a Description of 3 or 4 sorts of *Mills* with *Horizontal Sails*, and the Authors Opinion thereupon.

The third Part Treats of the Measure of running and spouting Waters; in the 1st. Discourse, are produced several experiments to find the quantity of Water passing through a Bore of an Inch Diameter, just under the Surface of the Water, which at length is concluded to be 14 *Paris Pints* in a Minute, or 72 *muides* in a natural Day: where by the way, notice is taken of the length of the *Pendulum* vibrating seconds, in parts near the *Equinoctial*, having been found at *Cayenne* a tenth, and at the Isle of *Goree*, near *Cape Verde*, an eighth of an Inch shorter, than at *Paris*, of which the Cause is proposed to proceed from the diurnal Motion of the Earth.

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The second Discourse shews by Experiment that the quantity of Water expended by a *jet d'eau* of the same Diameter of Bore, but at different hights of the reservatory, are in a subduple proportion of these hights; and it being found that at the hight of 3 foot, a *jet d'eau* of $\frac{1}{4}$ of an Inch Diameter, evacuated 14 *Paris* Pints, or 14 parts of 35 of the *Paris* Cube Foot in a Minute, thence is concluded the expence of Water at any other hight of the Reservatory through the same Bore.

The third Discourse shews that the quantity evacuated by different Bores at the same hight of the Reservatory, are as the Squares of the Diameters of the Bores, the which is proved both Mathematically and Experimentally: The fourth Discourse shews the manner of finding the quantity of Water which a River or an *Aqueduct* furnishes, which is illustrated by the Example of the *Seine* at *Paris*.

The fourth Part Treats of the height to which the Water of Fountains rises, and its first Discourse, shews that the *jets d'eau* never rise so high as their Reservatories, but allways fall short thereof, by spaces which are in duplicate Proportion of the heights they rise to, which is proved by several *Experiments*: The next thing inquired after is the best sort of *Ajutages* or spouts for *jets d'eau*, affirming from Experiment, that an even polished round hole in the end of the Pipe, gives a higher *jet* than either a *Cylindrick* or *Conical Ajutage*, of which yet the latter is the better. Lastly 'tis made out, that very great heights of Reservatory are altogether usefess, the Water being by its great Velocity dispersed into small drops and its force lost, so that the height of the *jet* is not proportionably encreased: A second Discourse of this Part handles the Amplitudes or Distances of *Oblique jets*, according to the Doctrine of *Galileo* and *Torricelli*, and concludes with a Geometrical way of finding the height of the Reservatory by the Horizontal Stream issuing out of a Hole bored in the side of the Pipe.

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The fifth and last Part treats of the Pipes that are to convey Water, and of the Strength necessary thereunto, and consists of 3 Discourses, the first whereof shews the size of Pipes requisite for the several expences of Water, proving that in small Pipes emptying the same Water, the Water running faster, has more friction and is consequently more retarded; to avoid which this Rule is given, that the Squares of the Diameters of the Pipes be as the quantity of Water to be expended, in which case the Water will run in all alike fast, and the friction be the same; and when a great Pipe branches into several smaller, distributed to differing *Jets*, the square of the Diameter of the main Pipe must be proportioned to the sum of all the Expences of its Branches; and for a Foundation of a *Calculus* of the most commodious size of Pipes, tis laid down that for a Reservatory of 52 foot high, whose *Ajutage* is half an Inch Diameter, the Pipe ought to be 3 Inches Diameter. The second Discourse Treats of the strength of Pipes requisite for bearing the weight of the Water, where are several pretty Experiments of the resistance of Solides. The last of all gives a method of distributing Water by Pipes into a City, and shews how those Pipes are to be cleansed from Mud, by leaving Apertures to let out the Water in those places where the pipes lie lowest; and from Air, by the like Apertures left on the tops of those eminences where the Pipes pass.

N.B. That the *Paris* foot Measure is to the *London* foot as 1279, to 1200, viz. 79 *Centesmes* of an Inch greater; so that to reduce the Experiments here produced, 'tis to be noted that 14 *Paris* Pints, or 14 parts of 35 of the Cube of the *Paris* foot, is equal to 3 gall. 5 pints, or 29 pints *London* Measure; and so much was evacuated in a minute through a Bore of a *Paris* Inch diameter, just under the Surface of the Water; but a Bore of a *London* Inch so placed, will pass but 3 gall. 1 pint or 25 pints our Measure in a minute at which rate near 73 Hogsheads will run through such a Bore in a Day.

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The same Quantity of Water will by the Experiment of our Author, furnish a *Jet d'eau* of the diameter of a quarter of a *London* Inch, when the Reservatory is at the height of 13 *French* feet, or 13. *f.* 10 $\frac{1}{4}$ *Inch. English*; and the Expences of Fountains of the same Bore being as the Square Roots of the heights of the Reservatory, 4932 gall. or 78 Hogs-heads will furnish a *Jet* of 16 foot high, with a Quarter of an Inch Bore. Generally the Rule is, that the Expences of all Fountains, are as the Square Roots of the heights of their Reservatories, into the Squares of their Bores, and according to what is delivered in the 5th. Part of this Book, the Squares of the Diameters of the Pipes must be proportioned thereto.

IMPRIMATUR,

John Hoskyns *Vice P. R. S.*
July 17th 1686.

Printed by *J. Streater*, and are to be sold by *Sam. Smith*
at the Sign of the *Princes's Arms* in *St. Paul's Church-yard*.

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This image shows a blank, aged, cream-colored page, possibly an endpaper or flyleaf from an old book. The paper has a slightly textured appearance with some minor discoloration and small dark spots. There are several prominent dark brown stains and spots, particularly a large, irregular stain in the upper right quadrant and a cluster of smaller spots in the lower right quadrant. The overall tone is a warm, off-white or light beige.

PHILOSOPHICAL TRANSACTIONS.

June the 26. 1686.

THE CONTENTS

1. **A**N Essay towards an Universal Alphabet, together with a farther essay concerning an Universal Primer, to which is added a Specimen of a new Character fitted to the said Alphabet by Fr. L. Reg. Soc. S.

2. Some farther Remarks on the instrument by an Anonymous French Author, for effecting a perpetual Motion, an account whereof is given in Num. 177 of these Transactions. by D. Papin. M. D. R. S. Soc.

3. A short Examen of the Stones sent the R. Society from Bern; of which there is a large account in the last Transaction. by Frederick Slare. M. D. Reg. Soc. S.

4. Two Observations of the last Eclipse of the Moon on Novemb. 30th last, made at Nuremberg; the one by Mr. G. C. Eimmart, the other by Mr. J. Ph. Wurtzelbauer; communicated by Mr. Theodore Haak R. S. Soc.

5. An Extract of a Letter written from Aramont in Languedoc near Avignon, giving a Relation of an Extraordinary Swarm of Grafshoppers in those parts, communicated by Mr. Justell. Reg. Soc. S.

An
ESSAY
 Towards An
UNIVERSAL ALPHABET.

By Mr. *Francis Lodwick* R. S. S.

HAVING observed a great difficulty in truly writing what is pronounced, or truly pronouncing what is written, either in our own or foreign Languages, by the Ordinary Alphabets now in use, arising either from the want of some Letters, or the differing Pronunciation of the same Character or Letter in differing Languages, and the irregularities of its various Sounds in any one Language; I saw a necessity of some such expedient as I have here attempted, *Viz. An Universal Alphabet*, which should contain an Enumeration of all such single Sounds or Letters as are used in any Language, which I have endeavoured by Examining all those Languages, which hitherto I have considered: Altho' this my attempt be not new, but what before by others hath been attempted, yet I hope what herein I have done will not be unuseful.

The Benefits of such a Collection being perfect.

I. Children from their first beginning, being taught and accustomed to the true Expression of all these single Sounds or Letters, will without difficulty be brought to pronounce truly and readily any Language how seemingly difficult soever

ever ; for the pretended difficulty to some Persons of Pronouncing some Letters, is only that they have not been accustomed to pronounce them, either single or in conjunction with others : and this difficulty is chiefly in Persons come to Age.

2. It will enable any one, accustomed to the true Pronunciation of this Alphabet, truly to describe the Pronunciation of any Language whatever, that shall in his hearing be distinctly pronounced ; so as another also accustomed to this Alphabet, altho' he before never had heard this Language pronounced, shall notwithstanding at first sight of such Writing, be able so truly to pronounce it, that it shall (if at all) very little differ from the Original Pronunciation. Whereas by the use of the common Alphabets, if any strange Language be written, another that's a stranger to that Language, shall never be able truly to pronounce such Writing, as it should be, or was by the Writer intended, nor even the Writer himself sometime after that he hath forgotten what Sound he designed to describe.

3. It will also be useful to perpetuate the true Sounds of any Language, and serve as a Standard thereof to after-Ages : For if all the single Sounds expressible, be here Characterized. *And that no one Character have more than one Sound, nor any one Sound be expressed by more than one Character* ; it cannot fall out that any Character should be falsely pronounced, but it will soon be discovered ; for this false Sound he giveth it, must be the true Sound of some other Letter of this Alphabet : and so none can Erre herein, but he that wilfully or carelessly will do it.

In this Collection I proceed according to these Rules.

1. **T**hat no true single Sound can be truly described or expressed by the Conjunction of any two or more other single Sounds, *Viz.* If a Vowel, by the Conjunction

of other single Vowels, or if a Consonant, by the Conjunction of other single Consonants.

2. That whatever Sound cannot be expressed or described, but by the Conjunction of two or more single Sounds, is no single but a compounded Sound.

3. That in every composition of single Sounds, the particular single Sounds which make up that Composition, ought to be truly and clearly discerned in the Sound of the Composition, otherwise it cannot be truly said to be a Composition, and composed of such single Sounds.

The Single Sounds

U Usually named Letters, are commonly distinguished into *Vowels* and *Consonants*. *Vowels* are such as are singly expressible, as, a, e, o, &c. *Consonants* are such as cannot singly be expressed without the Conjunction of a *Vowel*, as, b, d, f, g, &c.

Of Vowels

THe whole number of them are these 14 following, to which, for the better discerning of their Sounds, I have annexed so many words wherein they are expressed, all *English* but three, *Viz.* the 7, 8, 12, because no *English* words occurred to my *Memory*, wherein they are expressed.

1	a as tall	8	ui — muis <i>Lowdutch</i>
2	a — tallow	9	y — tile
3	a — tale	10	o — tone
4	e — tell	11	u — tunne
5	ea — teal	12	u — <i>une French</i>
6	i — till	13	oo — tool
7	u — <i>dure French</i>	14	ou — tould

These are the *Vowels*, each of which are long and short.
 Short as in the words, God, Man, Sin.
 Long as in Ball, Demand, Seen, &c.

Of *Diphthongs*

A *Diphthong* in the ordinary use of the Word signifieth a Compound of two Vowels, but those in ordinary so named, are most of them nothing but only single Vowels, as *ea*, *oo*, *ou*, *eo*, *ai*, in the Words *teal*, *tool*, *tould*, *people*, *main*, &c. That these are but single Sounds will appear, if we consider the Sounds of the Vowels singly, that make those supposed Compositions, and then whether those Sounds in Composition will make out the true Sound required; so as both of them may be clearly discerned in these pretended Compounds. For instance; in *ea* in *Teal*.

Consider the Sound of *e* in the Word *sent*, or in the Word *scene*; and *a* in the Word *ball*, or in the Word *and*, or in the Word *tale*, and then whether *e*, in either of the two Sounds going before, and *a* in either of the three Sounds following joyned together, will make out the true Sound of *ea* in the Word *teal*, if not, then is it a single Sound; thus, if you proceed to examine all the other, you will I doubt not find the same event, and I believe the true *Diphthongs* and *Triphthongs* of the *Greeks* were no other but a true expression of the single Vowels they joyned together, but in so short a time, as both or all three were express'd in the time that ordinarily one single *Vowel* was express'd.

Of Consonants.

The whole number of *Consonants* are these undermentioned, as nigh as I could Collect, by examining all the Languages I am acquainted with, or have heard express'd, and I think but few, if any, single *Consonants* have escaped my Notice, all which in this following Table I have ranged in 11 Files, and 6 Ranks.

I	2	3	4	5
1 B bond	D dark	J Jeft	G Game	=
2 P Pond	T tart	Ch. Cheft.	K came	=
3 Mmind	N name	gn <i>Seignior</i>	ng fong	=
4 =	dh this	J <i>Jean</i>	g gaen	} l.d. V Valley
5 =	th thing	fh fhall	ch dach	
6	n <i>danfe</i> Fr			F Folly

6	7	8	9	10	11
=	L lane	H hand	Y yarn	R rand	W wand
=					
=					
Z Zeal	lh W				
S Seal					

Fr sign. Fren.
Ld: Lowdutch
W. Welch

Fr sign. Fren.
Ld: Lowdutch
W. Welch

The First File containeth three *Consonants*, the Second six, the Third and Fourth ten, the Fifth and Sixth four the seventh two, the remaining four each one, in all twenty nine *Consonants*.

The second Rank in each File contains Derivatives [so I shall name them] in relation to the First Rank, or their Primitives, all alike in kind, so also all the Derivatives in the Third Fourth and Fifth Ranks, whereby their Sounds will be the better comprehended.

Those

Those places filled by two strokes (=) signifie that Sounds may be express'd by the same posture of the Mouth with their Primitives, answering in kind to those in the same Rank wherein they stand, but they would be so like in pronunciation to some others in the Table, that the difference would be too nice for common discernment, and also for that I have not observed them used in any Language I have heard express'd by a perfect Mouth, I thought it needless to characterize them.

As those of the Fourth and Fifth Rank in the First File are like those of the Fourth and Fifth Rank in the Fifth File, & those of the First, Second, & Third Ranks in the Fifth File, are like those of the same Ranks in the First File, so those of the First, Second, Third Ranks in the Sixth File, are like those of the same Ranks in the Second File.

Some of these above-mentioned twenty-nine *single Consonants*, are vulgarly supposed compounded, as *th*, *ch*, *sh*, *gn*, *ng*, &c. But if you consider the Sound of each *single Consonant* in the Composition apart, and then the Conjunction of them in that order, so as the *single Sounds* may be clearly discerned in the Composition, you will never make the Sounds required, and if neither by this nor by any other Conjunction the required *sound* can be made out, it must be a single and no compound Sound.

Whereas these single sounds, vulgarly described as Compounds, ought to have single Characters and Secondly, that some of the single Characters have in the same Language a different Sound, as *c* in the Words, *can*, *mice*; *g* in the Words *George*, *Game*, &c. and also a different Sound in different Languages, as *I* Consonant differently express'd in several Languages, as in *English*, *Low Dutch*, *French*, *Spanish*: and Thirdly, that some *single Sounds* are differently characterized in the same Language, as the Sound of *f* in *same*, and *c* in *mice*; (the same Sound by two different Characters;) so also *c* in *can*, and *k* in *kind* the same, &c. and the same also in different Languages, as *ch* in the *French* Word *chose*, and *sh* in the Word *shall*, the same, &c. It will be impossible

sible in the use of the present Characters or Alphabets, to add those wanting, and to correct and limit the Sound of others in use; thereby to constitute a perfect Alphabet, because people so long accustomed, or habituated to such corrupt and differing Expressions of the present Characters, will be always subject on the sight of the old, to give them those Sounds they have been used to, and to spell words according to their old and corrupt Custom, whatsoever Rules shall be set to the contrary; and therefore there will be a necessity of a whole new Set of Characters, both of *Vowels*, and *Consonants*.

Hitherto I have endeavoured to make a Collection of all the single Vowels and Consonants, which are used in any Language; in which, if I have not collected all those that are, yet in the method I have used therein, I hope I have attained nigher to it, than any other Collection extant. I have likewise shown the necessity of a new Set of Literal Characters, & such a one is this I here propose; First the Set of Consonantal Characters, are to be seen in the top of Page (137) being ranged in the same method & order with those in the foregoing Table. The first Rank in every file are those I name Radical Characters, the other succeeding Ranks have each a distinguishing Characteristical Addition to distinguish them one from another, which causeth some complication; but yet I judged it necessary to express the same in the Character, the more regularly to sort them into Classes, and to express the derivation of Letters of the same Organe, the one from the other.

The Set of Vocal Characters is likewise in the same Page with the Consonants; in writing they are to be placed over the Consonants, which they follow in Expression; and whereas some Syllables begin with a Vowel, place the 12th. Consonantal Character, answering to the *Hebrew, Aleph*; and over the same place the Vowel beginning such a Syllable.

This Character may seem somewhat to complicate for dispatch in ordinary Writing, but to be

the same with that now used, and I only designed it for that purpose, but for the Pen, others more convenient may be invented.

To distinguish the long Vowel from the short, add a prick to the Vocal Character.

The 9.11.12.13.14th. vocal Characters, are (for want of single strokes) compounded of the first and second.

The Diphthongues truly such (as I have before noted in the first Part) may be made by the Conjunction of the Single Vocal Characters in the order as they follow, and will be easily distinguished from the 5 foregoing compounded Characters of the single Vowels, because there will not lightly occur any Diphthongs compounded of the first two Vowels.

The Accent may be a thwart line under the Syllable that is to be accented.

The 4 Marks of pauses ordinarily used, namely, ; ; . . may be continued.

The Characters signifying the various Modes of Expression may be these following, and ought to be placed at the beginning and end of every Sentence requiring it.

[]	Explication.	}	{	?	? Interrogation.
()	Parenthesis.	}	{	!	! Wonder.
! !	Emphasis.	}	{	z	z Irony.

A Second Essay concerning the UNIVERSAL
PRIMER.

AS the present Alphabets are imperfect, (as in the foregoing Essay is declared,) so are also the Primers or first Books, wherein Children and others are Taught to Spell and Read, first in not having a perfect Alphabet. Secondly in not being digested in such a Method as is fit and proper to teach them, as they ought to be taught, for the usual way of teaching to spell, is to dismember every syllable (of more than one Letter) into many Syllables, by expressing every Letter apart, and Syllabically, and the Consonants with such a Vowel as they are ordinarily named with, and then requiring them to joyn all these Syllables into one word, but how preposterous this method is, one instance for all will manifest, suppose the monosyllable *Brand* be to be spell'd, they will teach them thus to dismember it *Bee, er, a, en, dee*, and then require them to joyn these into one Syllable, which it is impossible to do, and they must be necessitated as they have begun, to express this one Syllable by five Syllables, which was not designed, whereas they should teach them to express every Syllable entire at first sight, without dismembring it. And to do this, they must proceed gradually, first beginning with the most simple Syllables, and so by degrees proceeding to the more difficult and Compounded, till they can readily pronounce a whole Syllable at first sight, even the most difficult that are.

To that end, let all the Primers be thus contrived; at the top of the leaf, let all the Vowels be placed singly in order as they follow in one Rank, and under the same place, Syllables, first, of one Vowel and one Consonant, following it throughout all the Variations; then of one Consonant and one Vowel following, 2dly. of two Consonants before, and one Vowel following throughout the Variations, 3dly, of one Vowel and three or four Consonants

sonants following. And of three Consonants going before, and one Vowel following. 4^{thly} of one, two or three Consonants going before a Vowel, and one two, three, or four Consonants following. 5^{thly}, of some Syllables with Diphthongs or Triphthongs. For Instance,

a. e. i. o. u. &c.
ab. eb. ib. ob. ub. &c.
ad. ed. id. od. ud. &c.
ba. be. bi. bo. bu. &c.
ald. eld. ild. old. uld. &c.
dra. dre. dri. dro. dru. &c.
balm. belm. bilm. bolm. bulm. &c.

After this place, a number of words of two, three, or four Syllables, from the more easie to the most difficult expressions, without heed to their Significations.

Further let there follow some words of several Syllables, with the Accent Variously placed, as on the first, second, third, &c,

Let there be two or three small Discourses writ with this Alphabet, in so many several Languages, with the Accent rightly placed, and truly distinguished by their pauses. And thus you have a perfect Primer for the Design.

Of teaching with this Primer.

First, begin to teach them the true sound of all the Vowels singly, then proceed to the following single Syllables, beginning with the easiest of Expression, and so proceed on gradully to the most difficult, and then to the words of more Syllables, and lastly, to the use of the Accent and Pauses when the learner hath past all these, you may exercise him in the reading of the following Discourses, and therein let

him exactly observe the Accent and the Pauses, and hitherto it will not be Material, whether the Syllables be significant or not, or whether they understand the small discourses or no, for hitherto we suppose them by this instruction, only capable of Reading or uttering exactly whatsoever is written in this Alphabet and Character, in what Language soever, which is the design of this Primer.

And to gain a greater readiness and habit herein, teach them to write truly what they hear distinctly expressed, according to this Alphabet, proceeding therein gradually as before, and rightly to place the Accent and Pauses, and also the use of the Signes of the different modes of speaking.

In Teaching, Observe these necessary Rules.

1. Proceed leisurely and orderly. Suffer them not to pass by any mispronunciation uncorrected, from the beginning to the end, cause them so oft to repeat a wrong pronunciation, till with your assistance they pronounce it truly, allowing for the natural defects in the Speech of some persons, the younger will learn these pronunciations more easily, but the elder may attain them also, although with more difficulty.

2. Suffer them at no hand in spelling, to dismember any Syllable by repeating the Letters singly, but that they pronounce them whole as they find them.

Think not this method tedious, the end will crown and reward the labour, and what the learner hath thus attained and habituated himself to, will remain with him all his life time.

This new Primer will without change except in the Title, be the same for all Nations and Languages.

The following Page gives the Alphabet and Character mentioned in this Discourse, with the Lords Prayer in English, written therein as a Specimen.

The Universal Alphabet .

137

The Table of Consonants							
	1	2	3	4	5	6	7
1	7 b	7 d	7 j	7 g	7 =	7 =	p l
2	h p	h t	h ch	h k	h =	h =	
3	m m	m n	m gn	h ng	m =	m =	
4	b =	b dh	b j	b g	b v	b z	B Lh
5	b =	b th	b sh	b ch	b f	b s	
6		h n̄					
	8	9	10	11	12		
	h h	y y	h r	y w	l N		

1	2	3	4	5	6	7	8	9	10	11	12	13	14
a	a	a	e	ea	i	u	ui	y	o	u	eu	oo	ou

The Lords Prayer in English.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 104

Some further Remarks on the Instrument proposed by an Anonymous French Author, for effecting a perpetual Motion, an account whereof is given in No. 177 of these Transactions, by Dr. Papin. M.D: R.S.S.

HAVING seen in the *Journal des Sçavans* of May 13th. and in the *Nouvelles de la Republique des Letres* of the Month of June, that the Author of the Perpetual Motion is not satisfied, but doth endeavour to answer the Objection that I propounded against his contrivance, in the *Philosophical Transactions* of the Month of December, 1685. I find I must explain my self more at large than I did in that Paper; but I begg his pardon if I say nothing concerning the new disposition, which he say's might be given to his Engine: My want of time makes me avoid new matters of dispute, and I think it enough for me, if I do but shew that his first Description can never succeed.

I am very sorry, that this Author took so much trouble in trying his Bellows with several Liquors, as Oyl, Mercury, Water. I thought I had sayd nothing, that might make him beleive, that I did in the least question the truth, which he intended to prove against me by those Experiments; and without any tryals I am fully enough convinced, that the *Mercury* in his Engine must follow the lawes of the *equilibrium* of fluid Bodies: But the consequence which he draws from that Principle, seems to me very groundless; for altho' the lowermost part of the Bellows be pres't by the weight of 40 inches of *Mercury*, it doth not follow, that all the parts which are situated higher must bare the same pressure: To the quite contrary, it is plain that the upper part having no *Mercury* above it bears none at all; the parts that lye in the middle near the *Axes* of the Bellows, bear but 20 inches, and so all the rest must bear more or less, according as they lye higher or lower: It is evident therefore, that there are

as many parts that bear less then 20 inches, as there are that bear more, and the increase of pressure following an Arithmetical Progression, it is undenyable, that all these pressures added together, will do no more than one uniform pressure, that would be equal to 20 inches every where.

Having thus found the quantity of pressure caused by the *Mercury* within the Bellows, we must remember that the pressure of the *Atmosphere* within the same Bellows, is equivalent but to 5 inches, as I observed in my first Paper *vid.* Philosophical Transaction No. 177 pag. 1241: So that we find that the inward pressure is equivalent but to 25 inches of *Mercury* in all. Now the pressure of the *Atmosphere* upon the outside is every where equal to 27 inches; from whence it appears that the pressure without is stronger than the pressure within, and so I had reason to say, that the Bellows standing upright, must rather shut than open.

I did not think to have given this Computation so at large, but I have been necessitated to do it (as I said in the beginning) since my first Paper was not sufficient to make me be understood by the Author of the Perpetual Motion, however, I will be careful to save the time of the Reader as much as I can; and although I might observe some other things in his Description, that will increase the difficulty of opening the Bellows, I forbore to speak of them; and I will stick only to that which is most material, and makes his Perpetual Motion to be altogether impossible.

As for the Argument the Author drawes from comparing his Engine to an ordinary *Siphon*; I do beseech him to consider what a difference there is between a *Siphon* that lets the water run down at the bottom, and his Engine; that should gather up the heavy liquor into the highest part of the Instrument, and I do not question but he will acknowledge the weakness of this Argument.

A short Examen of the Stones sent the R. Society from Berne, whereof an account is given in the last Transaction: By Frederick Slare M.D.R.S.Soc.

THose that have made Experiments in *Hydrostaticks*, do find all pure Metals to have Specifick and peculiar Gravities to themselves, and those very differing one from another. From this hint I formerly endeavoured to discover the Nature of the *Calculus Humanus* (which I found to have no attributes that are proper to a real Stone) and bringing them to a *Hydrostatical Test*, I found them very differing in their specifick Gravity, and very remote from an equal proportion to their bulke of common Stone, when weighed in Water. After the same manner in order to the better inquiry into the Nature of this *Helvetian Concretion*, I made it my first attempt to compare it with its Relative *Pondus* to Water, having first of all satisfied my self that there is a certaine Term of Gravity that all true and genuine Stones (the which are a sort of *Natural Vitrifications*) do meet in or arrive at : That is, that there is a Standard of Gravity so competent to all real Stones, that where they decline from this Standard, we have good reason to question those *Concretions*, whether they are Stones or no. The Standard of Gravity for real Stones I find to be generally about two to one of the common *Fluid*, that is the bulke of the former, to answer double the bulke of the latter, and a little more. In our *Examen* of this *Concretion*, this Stone was very hard and seemingly heavy, but being brought to the *Hydrostatical Tryal*, it was very Spungy, for when it lay under Water, there passed a good while before I could clear it of the lurking bubbles, so that it grew heavier, from time to time as the bubbles were expeld, and at last arrived near the Standard of a true Stony *Concretion*, or rather somewhat beyond

This

This Stone sent us for thirteen Dramms, must either have been *Averdupoise*, or else is wasted something, for I found it only to weigh

In the *Air* 12 dr. — 36 gr.

In *Water* 6 dr. — 48 gr.

The difference betwixt the weight of this Stone so called, in the *Air* and in *Water* comes to } 5 dr. — 48 gr.

The proportion betwixt this *Concrete* and Water, proves to be as 756 to 348, or as two and somewhat more than a sixth to one. This extraordinary *Pondus* or Gravity makes the matter of a greater consideration, and worthy our further Inquiry whether there be not some Metallick Ingredient in it.

Whilst I was making these Tryals, I was willing to compare this matter with common *Chalk*, which I found specifically lighter, bearing only the proportion to Water of 521 to 290, considerably short of that of 2 to one. Shells and Testaceous Bodies do very near agree with this matter; which takes off the former opinion that this Patient, had perhaps devoured Wall, Lime, and such like Testaceous Matter, from whence the Stone might receive its original: For this being broken into peices, will not so easily cement again into so compact a Body as it was formerly of, as we see in *Whiteing* that is lighter than *Chalk*: Wherefore this being vastly heavier than *Chalk*, can scarce be thought a *Concretion* of such a matter.

I then compared it with petrified Water, being an Icecle that was broken off a *Grotto*, where the petrifying Spring did furnish enough: This came very near the Gravity of our Rarity, and the usual weight of ordinary Stones; a peice that weighed five drams out of the Water, discovered its weight to beare the proportion of 403 to 184, or 756 to 345 to that of Water. This Anomalous Substance being so near the weight of our petrified Water, would almost in-

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cline

cline a Man to believe it real Stone, and the rather, because we are informed the Patient Drank much Water. Moreover, the following Experiments upon this matter, do seeme to give proof of its being rather of the ordinary Stony Constitution, than of that which is proper to Animal *Concretions*. For Instance, we first of all poured upon it ordinary Vinegar, and it presently wrought upon it with a hissing noise, as it did on the petrified Water when powder'd. We poured on it *Spirit of Vitriol*, and that also wrought upon it and dissolved it, but let it fall again, as *Aqua-fortis* does *Tinn* when it has corroded it; which is agreeable to the Relators Account.

But I do not find he used *Spirit of Salt*, for this wrought upon it very vigorously, and presently dissolved it, and kept so without any Precipitation.

These Experiments do all of them distinguish this *Concret* (whatever it be) from the ordinary *Animal* Ones, as the Stone in the *Bladder*, *Kidney*, the *Tophi*, &c. for these will not be dissolved, or in the least corroded by any of the mentioned *Acids*: Tho' *Spirit of Nitre* be a general *Menstruum*, that dissolves them all readily.

There are some things yet very strange, which make this Case peculiar: Namely that those Stones which are generated in the habit of the Body, I mean in the very ferous part of the Blood, and those that passed the *Bladder* have just the same Nature, with those that are *extra habitum*, even those evacuated *ex Stomacho* and *ex Ano*: for one as well as the other will be presently corroded, by so mild an *Acid* as plaine Vinegar.

The Relator in his *Analysis* of these *Stones*, gives an Account of so great a quantity of *Volatile* and *fixt Salt* obtained by his distillation, that those *tryals* do necessarily make it an *Animal Substance*; which Experiment so far failed us, that I am not satisfied as to the matter of Fact.

Thus we must at present leave the Discovery imperfect, for according to the Description the Case is very Singular; espe-

especially as to those *Concretions* generated *extra Habitum* in the Stomack and Guts: That these should abound with *Volatile Salt* is strange, I have tryed the *Bezoar Stone* said to be generated in the Stomacks of some *Animals*, and could obtain no *Volatile Salts* from that Substance; though it herein agree with this Substance, that it is easily wrought on by many *Acids*.

A Short Review.

We need not much doubt, though it be not mentioned, that those cragged and large *Stones*, were ejected *per Anum*, for the *Oesophagus* could not possibly pass them.

The *Stone* in the *Kidney* is often so soft, that it answers the *Cylindrical Figure* of the *Ureter*, but these are much harder, and do not in any measure comply with the Constriction of the *Bowels*.

We may in some measure question that principle, or rather *Hypothesis* of *Acidum*, our Correspondent trusts to, for the *Combination* or *Coagulation* of the *Humors* in the *Body*, in order to this *Petrification*; it being supposed not proved.

We may also question whether the *fixt* or *Alcalizate Salt*, found in the *Caput Mortuum* after *Distillation*, were really pre-existent in that forme in the *Blood*, or other *Humors*, and not rather a product of the *Fire*.

It may not be impertinent to inquire after some metallick particles, whether they may not be an *Ingredient* in this ponderous *Stone*, especially since *Dr. Lister* has found them in much lighter *Concretions*, as those of the *Kidneys* are. For though we find them not in this unprepared stone, yet after *Reverberation* or a strong *Calcination*, many bodies have detected an *Iron Contexture*. The *Marchasite* it self, though very pregnant with *Iron*, shews it not, till it has been calcined: which shall be done with some of the remainder, after the *Tryall* by *Distillation*.

To deviate a little, though not from a Proposition made before the *Royal Society*, which was to endeavour what we could, to reduce bodys to such settled Standards, as might somewhat represent their Natures, and free us from false and confus'd Conceptions of *Things*, or give us an account of some bodies, whose Natures we are doubtful of. In a small Treatise of the *Calculus Humanus*, I found reason to complain of the Imposition of our Senses upon our Conceptions in calling that a Stone by its external appearance, when it has no real properties of a Stone. I have also, in this, Reason to except against *Chalke*, (commonly taken for a Stone) for being brought to the *Hydrostatical Examen*, (if that may be allowed as a Standard) it wants much of the true Consistence of a Stone, as the Calculation mentioned does manifest. For it wants much of that weight, which real Stones are proved to have in Water, and it may perhaps be better reckon'd amongst *Boles* than *Stones*. I found this true, not only in Chalk, but various other bodies taken for granted to be Stones at large: some of which are nearer *Earths* than *Stones*; others have nothing but *Earth* and *Sulphur* and *Metall*, and yet must be called Stones, (as all *Marchasites* are.) Of these the former, (namely the *Boles*) many of them fall short of our Standard, others are more ponderous and so exceed our Standard, whereas true *Stones* though differing much in hardness, whether Pebbles, Flints, petrified Waters, &c. do answer the same Standard of Specifick gravity that a Diamond does. But that these natural bodies should as exactly agree, as Metalls do; when they are by art separated from all *Heterogeneity*, cannot be expected in Compound Bodies, though I doubt not but much use may be made of it by those that are more accurate:

A further Tryal of the said Stones by Chymicall distillation. By the same.

WE brought this Stone to a gross powder, and conveyed it into a coated *Retort*, which coated *Retort* was kept for some Houres in a naked Fire, so hot that the Glass melted.

The quantity we put into the retort amounted to half an ounce, twenty Graines. The liquor that came over seems scarce to afford 3 or 4 drops, which looks like Spirit of Harts-horn rectified, and smells much like the same: which plainly discovers it an *Animal substance* though it affords much less than the *Calculus Humanus* does: and by consequence gives us a much larger proportion of *Caput Mortuum* or *Residuum* in the *Retort*: All which is very consentaneous to the nature of the *Stone*, for its Specific Gravity was much heavier than the *Stones* are, we usually find in the Humane body; and therefore the parts may be supposed more fix'd, or to consist of fewer volatile parts, such as are carryed over by Distillation.

We weigh'd the Remainder in the *Retort* and it came to three Drams and fifty Graines; Ten Graines of which seem'd to hang about the neck of the *Retort* in the form of a dirty hard baked Oyl. The other 20 Graines are partly gone off in Vapour through the Lute, and what we find in the Receiver in a liquid form.

We tryed part of this *Caput mortuum* by applying Mr. Haaks strong Magnet, to enquire whether it contained any *Iron Particles*, but did not find any would adhere. However there remains yet one Tryal to be made, and that is to give it a much stronger Reverberation in the Fire, and then to see whether some Particles will not prove *Martial*, which may be done at another season.

Two Observations of the last Eclipse November 30th last, made at Nuremberg; the one by Mr. G. C. Eimmart, the other by Mr. J. Ph. Wurtzelbaur: Communicated by Mr. Theodore Haak R. S. S.

THis Eclipse of the *Moon* was the more remarkable, for that it fell out very near the *Apogæon* of the *Moon*, and was nearly central; so that the duration was as great as possible. But so it hapned, that neither at *London*, nor *Greenwich*, nor *Paris*, it could be seen by reason of thick Clouds, for the whole time intercepting the sight of the *Moon*: The only Account we have received is already published, from Letters of the Famous Mr. *Hevelius* of *Dantzick*, in Num. 178 of these *Transactions*: And now these two from *Nuremberg*, made by the Industrious Observers Mr. *Eimmart* and Mr. *Wurtzelbaur*.

The Observation of Mr. Eimmart was as follows.

8^h. 19. min. the *Penumbra* was very obscure, and the beginning of the Eclipse was at hand.

9^h. 23^m. 30^s. the Eclipse was begun, the quantity almost half a *digit*, and the distance between the cusps was about 42 degrees of the *Moons* limb. and *Palus Mareotis* was just all Eclipsed; hence we may conclude the beginning about 9^h. 21^m. 30^s.

10^h. 23^m. 30^s. as near as I can collect from the Observators words, was the time of the total Immersion into the shadow; to verifie which, the Azimuth of the *Moons* center was observed to the East, 41^{gr}. 48^m. 2^{min}. 12^{sec}. of time after the said Immersion.

12^h. 13^{min}, or 10^m. 13^{sec}. before the Culmination of the right shoulder of *Orion*, was the Emerision or first appearance of the *Moon* out of the total Darkness.

13^h. 14^{min} fere was the just end of the Eclipse, being 2^m. 20^{sec}. before the Culmination of *Sirius* or the great Dogg.

Whence

Whence the middle of this Eclipse should have hapned at 11h. 18min P. M. at Nuremburg : the total duration 3h. 52min. 30sec. and the total darkness 1h. 49m. 30s.

The Meridian Altitude of the *Moons* upper limb was observed 63gr. 23m. 50sec. and the *Moons* apparent Diameter while totally Eclipsed was found 30m. 7sec.

The other Observer Mr. *Wurtzelbaur* made use of the Pendulum Clock, corrected by *Altitudes*. According to his Observation.

9h. 23m. 30sec. was the beginning of the Eclipse, at about 119 degrees of the limb of the *Moon* in *Hevelius's* *Sele-nography*.

9h. 24m. 50sec. *Palus Mareotis* was all covered.

10h. 25m. 20sec. The Total Immerfion ; about the 299th degree of the limb of the *Moon*.

12h. 11m. 30sec. The *Moon* began to Emerge out of the shadow, about the 112th degree of her limb.

13h. 14m. 30sec. The End of the Eclipse about the 295th degree of the limb.

By these Observations the middle of the Eclipse ought to have been about 11h. 19m. P.M. at Nuremburg, differing but one minute from Mr. *Eimmarts* Observation. The duration will be 3h. 51min. and the total Darkness 1h. 46m. The Longitude of Nuremburg has been formerly stated 11 degrees from London, & since found to be so by Observations of the last Eclipse of the Sun July 2d 1684, which made it 44½ min. of time. So that the middle of this Eclipse at London should have been 10h. 34½m. which from the Observation of Mr. *Hevelius* had been formerly concluded 10h. 35m.

An Extract of a Letter written from Aramont in Languedoc near Avignon, giving an account of an extraordinary swarm of Grasshoppers in those parts; communicated by Mr. Justell R. S. S.

Since you demand of me a Relation of the *Grass-hoppers* that have eaten up our Harvest the last Year, and which
give

give us so much trouble to destroy them this, I will do what I at present can to satisfy you. These Insects are undoubtedly of a peculiar *species*, although to look on them, they appear in nothing different from the common sort, but they take their flight like Birds, which is particular to them. They are much about an Inch in length, of a Grey Colour; The last Year the Earth in some places was covered 4 fingers thick with them in the morning before the heat of the Sun was considerable, but as soon as it begun to be hot, they took wing and fell upon the Corn, eating up both leaf and ear, and that with such expedition, by reason of their great number, that in three hours they would devour the Corn of a whole field, which you will hardly conceive unless you had seen it, after which they again took wing and their swarms were so thick, that they covered the Sun like a Cloud, and were whole hours in passing. They flew against the Wind, and went over the Castle which is very high, and seas'd upon another field of Corn which they destroyed like the former. After having eaten up the Corn, they fell upon the Vines, the Pulse, the Willows and even the Hemp notwithstanding its great bitterness. Afterwards about the end of *August* they ceased flying, and copulated, and the Female stuck her taylor into the hard Earth where she cast a foam, and made therewith in the ground, a hole as big as that of a Goose quill, and about an Inch long, wherein she laid her Eggs, which are much of the size of Millet seed, there would be sometimes 50 of these Eggs in a hole, which are so covered over with the same Earth that the Water does not get in. After this all these Insects died and stunk very much. They begun this Year to hatch in the Month of *April*, and some there are, that are not yet hatched. In *March*, we thought upon destroying their Eggs which lye not above a fingers breadth in the Earth, and we took of them 180 Quintals being 9 Tuns: it had been well if we had thought of this expedient sooner. Since their hatching they have taken above 15 Tuns of the young Grasshoppers

hoppers which are not yet bigger than flies. There are yet a multitude that have escaped us because they are in the Corn which is too forward to be gone into, without spoiling it. They have undone the People of our parts, who had no Harvest the last Year, and it will cost above 3000 Livres to destroy them this year. They have taken them in Abundance in the Neighbouring Villages. If this care had not been taken, there would have been enough of them to have eaten up the Corn of the whole Province.

Whereas in the last Transaction an Historical Account was promised of the Trade Winds, the Patience of the Reader is entreated till the next; for by reason of the Absence of a Person extraordinarily Knowing in this Matter, whose Information was thought necessary, the said Account could not as yet be perfected.

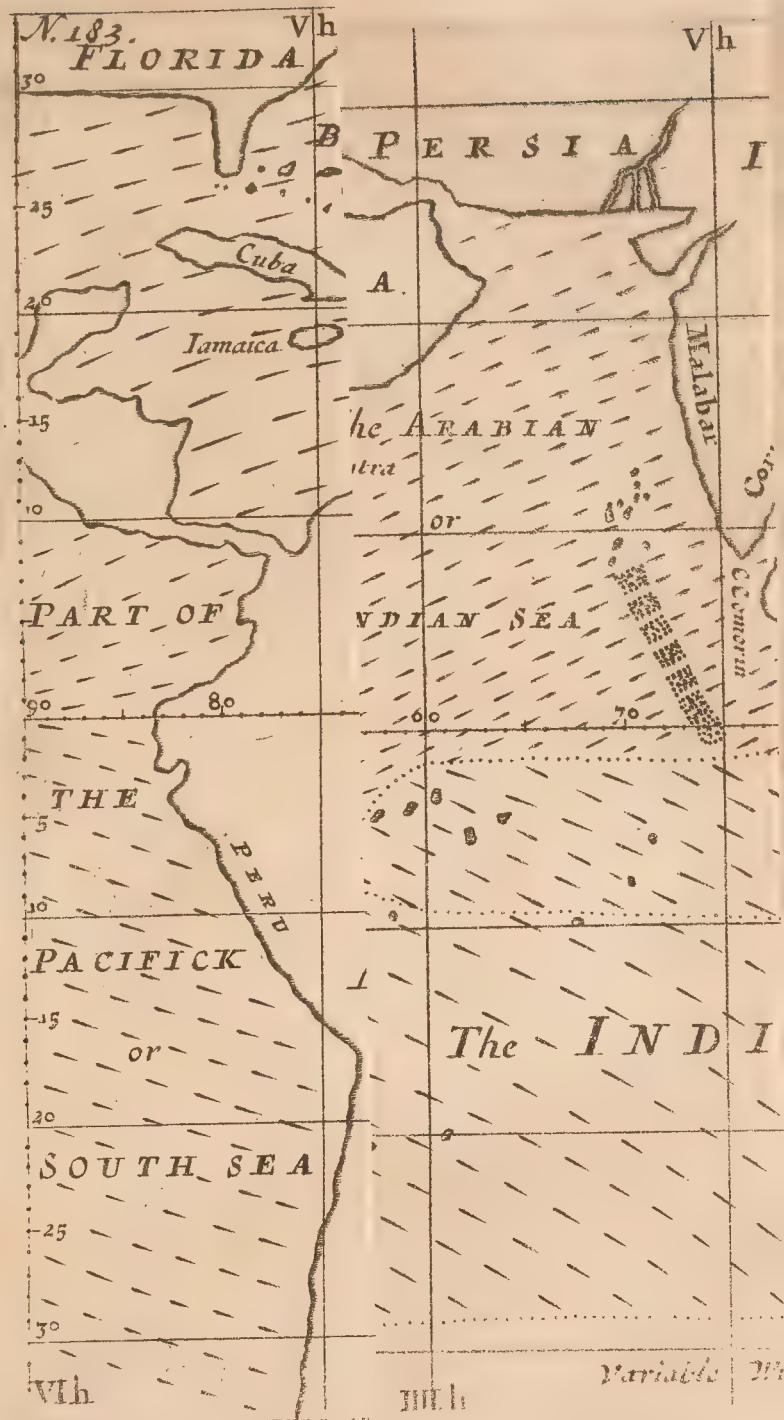
Erratum in Num. 181. Pag. 112. l. 6. r. a Northerly Wind, and in Scotland a Southerly.

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PHILOSOPHICAL

TRANSACTIONS.

For the Months of *July, August and September* 1686.

THE CONTENTS.

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2. *An Historical Account of the Trade Winds and Monsoons, observable in the Seas between and near the Tropicks, with an attempt to assign the Physical Cause of the said Winds,* by E. Halley. 3. *A Dioptrick Problem, Why four Convex Glasses in a Telescope shew Objects Erect,* by William Molineux of Dublin Esq. R. S. Soc. 4. *An uncommon Inscription lately found on a very great Basis of a Pillar, dug up at Rome; with an Interpretation of the same,* by the Learned Dr. Vossius. 5. *Several Observations of the Eclipse of Jupiter by the Moon on March the 31th. 1686. St. Vet. (whereof some account has already been given in Transaction. No. 181.) viz. of Mr. Cassini at Paris, of P. Bonfa at Avignon, of Mr. Zimmerman and M. Wurtzelbauer at Nuremburg.* 6. *A Letter of the famous M. Hevelius, Consul of Dantzick to the R. Society, containing his Observation of the same Eclipse at Dantzick.* 7. *An account of a Book. Methodus Figurarum lineis rectis & curvis comprehensarum Quadraturas determinandi. Authore J. Craige. 4to. Londini. 1685. With an addition thereto by the Author.*

*An Extract of two Essays in Political Arithmetick
concerning the comparative Magnitudes, &c. of
London and Paris. by Sr. Wm. Petty Knt. R.S.S.*

The excellent Author of these two Essays, has in several former of the same Nature made it appear that Mathematical Reasoning, is not only applicable to Lines and Numbers, but affords the best means of Judging in all the concerns of humane Life. In the present he endeavours to prove *London*, as it now is, the most considerable City now in being, by shewing it much to exceed *Paris*, (which not only the *French* but foreigners have asserted to be the chief City of *Europe*.) both in People, Housing, and Wealth: The first by comparing the Bills of Mortality, whereby he finds that the People of *London* are as many as those of *Paris* and *Rouen* put together. The second by comparing the number of Houses, which by the Chimny-Books are found above 80000 in *London*, whereas a great Author among the *French*, (who seldom fail to magnifie their own things,) reckons but 50000 Houses in *Paris*. As to the third, to wit the Wealth, he conceives that there is yet a much greater disproportion, there being no comparison between them for Trade, and besides a good argument drawn from the Law-Suites of both places, he concludes from the *Paris* bills of Mortality, that two 5ths of the People of *Paris* are so poor that they chuse rather to die in Hospitals, than lie sick at their own Charges; and that a third of the whole People of that City, die out of the most wretched Hospital of *L'Hôtel Dieu*; whereas at *London* there dies scarce one in fiftie in our Hospitals. Hereupon in the second Essay, our Author extends his Charity to those poor wretches, shewing how by a reasonable expence, 3000 persons might be there saved *per Annum*, who die for want of good accommodation. The whole is so close writt, that it will not bare Epitomizing, wherefore I rather recommend it to the Curious who cannot but be satisfied therewith.

An

An Historical Account of the Trade Winds, and Monsoons, observable in the Seas between and near the Tropicks, with an attempt to assign the Physical cause of the said Winds, by E. Halley.

AN exact Relation of the constant and Periodical Winds, observable in several Tracts of the Ocean, is a part of Natural History not less desirable and useful, than it is difficult to obtain, and it's *Phænomena* hard to explicate: I am not Ignorant that several Writers have undertaken this subject, and although *Varenius* (*Lib. I. Chap. XXI. Geo. Gen*) seems to have endeavoured after the best information from *Voiagers*, yet cannot his accounts be admitted for accurate, by those that shall attentively consider and compare them together; and some of them are most evident mistakes; which, as near as I can, I shall attempt to rectify, having had the opportunity of conversing with Navigators acquainted with all parts of *India*, and having lived a considerable time between the *Tropicks*, and there made my own remarks.

The substance of what I have collected is briefly as follows.

The Universal Ocean may most properly be divided into three parts. *viz.* 1. The *Atlantick* and *Æthiopick Sea*: 2. The *Indian Ocean*: 3. The Great *South Sea* or the *Pacifick Ocean*; and tho' these Seas do all communicate by the South, yet as to our present purpose of the *Trade Winds*, they are sufficiently separated by the interposition of great tracts of *Land*; the first lying between *Africa* and *America*, the second between *Africa*, and the *Indian Islands* and *Hollandia Nova*; and the last, between the *Philippine Isles*, *China*, *Japan* and *Hollandia Nova* on the *West*, and the *Coast of America* on the *East*. Now following this natural division of the Seas, so will we divide our History into three parts, in the same order.

I. In the *Atlantick* and *Aethiopick* Seas, between the *Tropicks*, there is a general *Easterly Wind*, all the Year long, without any considerable variation, excepting that it is subject to be deflected therefrom, some few points of the *Compass* towards the *North* or *South*, according to the position of the place. The Observations which have been made of these deflections, are the following.

1. That near the coast of *Africa*, as soon as you have passed the *Canary Isles* you are sure to meet a fresh Gale of *N.E.* Wind about the Latitude of 28. degrees *North*, which seldom comes to the *Eastwards* of the *E.N.E.* or passes the *N.N.E.* This Wind accompanies those bound to the Southward, to the Latitude of 10 *North*, and about 100. Leagues from the *Guinea Coast*, where till the 4th. degree of *North Latitude*, they fall into calmes and *Tornadoes*, of which more hereafter.

2. That those bound to the *Caribbe Isles*, find, as they approach the *American* side, that the aforesaid *North-East Wind*, becomes still more and more *Easterly*, so as sometimes to be *East*, sometimes *East by South*, but yet most commonly to the *Northward* of the *East* a point or two; seldom more. 'tis likewise observed, that the strength of these *Winds* does gradually decrease, as you saile to the *Westwards*.

3. That the limits of the *Trade* and *Variable Winds*, in this Ocean, are farther extended on the *American* side than the *African*: for whereas you meet not with this certain *Wind* till after you have passed the Latitude of 28 degrees on this side; on the *American* side it commonly holds to 30. 31 or 32 degrees of *Latitude*; and this is verified likewise to the *Southwards* of the *Equinoctial*, for near the *Cape of Good-Hope* the limits of the *Trade Winds*, are 3 or 4 degrees nearer the *Line*, than on the coast of *Brazile*.

4. That from the Latitude of 4 degrees *North*, to the aforesaid limits on the *South* side of the *Equator*, the *Winds* are generally and perpetually between the *South* and *East*, and most commonly between the *South-East* and *East*, observing al-

always this Rule, that on the *African* side they are more *Southerly*, on the *Brasilian* more *Easterly*, so as to become almost due *East*, the little deflection they have being still to the *Southwards*. In this part of the Ocean it has been my fortune to pass a full year, in an employment that obliged me to regard more than ordinary the Weather, and I found the Winds constantly about the *South-East*, the most usual point *S E ½ E*; when it was *Easterly* it generally blew hard, and was gloomy, dark, and sometimes rainy weather; if it came to the *Southwards* it was generally Serene, and a small gale next to a Calme, but this not very common. But I never saw it to the *Westwards* of the *South*, or *Northwards* of the *East*.

5. That the season of the Year has some small effect on these *Trade Winds*, for that when the the Sun is considerable to the *Northwards* of the *Equator*, the *South-East Winds*, especially in the straight of this Ocean (if I may so call it) between *Brasile* and the Coast of *Guinea*, do vary a point or two to the *Southwards*, and the *North-East* become more *Easterly*; and on the contrary when the Sun is towards the *Tropick* of *vs*, the *South-Easterly Winds* become more *Easterly*, and the *North-easterly Winds* on this side the *Line* were more to the *Northwards*.

6. That as there is no general Rule that admits not of some exception, so there is in this Ocean a tract of Sea wherein the *Southerly* and *S. West* Winds are perpetual, viz. all along the Coast of *Guine*, for above 500. Leagues together, from *Sierra Leona* to the *Isle* of *St. Thomas*; for the *South-East Trade-Wind* having passed the *Line*, and approaching the Coast of *Guinea* within 80 or 10 Leagues inclines towards the shore, and becomes *S. S. E.*, and by degrees, as you come nearer, it veers about to *South*, *S. S. West*, and in with the land *Sout -West*, and sometimes *West South-West*; which variation is better expressed in the Mapp hereto annexed, than it can well be in words. These are the Winds, which are observed on this coast when it blows

true, but there are frequent Calms, Violent suddain Gusts called *Tornado's*, from all points of the compas, and sometimes unwholsome foggy *Easterly Winds* called *Hermitaa* by the Natives, which to often infest the Navigation of these parts.

7. That to the *Northwards* of the Line, between 4 and 10 degrees of Latitude, and between the Meridians of *Cape Verde*, and of the *Eastermost Islands* that bear that name, there is a tract of Sea wherein it were improper to say there is any *Trade Wind*, or yet a Variable; for it seems condemned to perpetual Calms, attended with terrible Thunder and Lightning, and Rains so frequent, that our Navigators from thence call this part of the Sea the *Rains*: the little Winds that are, be only some suddain uncertain Gusts, of very little continuance and less extent; so that sometimes each hour you shall have a different Gale, which dies away into a Calme before another succeed; and in a fleet of Shipp in sight of one another, each shall have the Wind from a several point of the Compass; with these weak *Brizes* Shipp are obliged to make the best of their way to the *Southward* through the aforesaid six degrees, wherein 'tis reported some have been detained whole months for want of Wind.

From the three last observables is shewn the reason of two notable occurrents in the *East-India* and *Guinea* Navigations. The one is, why notwithstanding the narrowest part of the Sea between *Guinea* and *Brasile* be about 500 leagues over, yet Shipp bound to the *Southward* sometimes, especially in the months of *July* and *August*, find a great difficulty to pass it. This happens because of the *South-east Winds*, at that time of the year commonly extending some degrees beyond the ordinary limit of 4 degrees *North Lat.* and withall they come so much *Southerly*, as to be sometimes *South*, sometimes a point or two to the *West*; there remains then only to plie to Wind-ward, and if on the one side they stand away *W. S. W.* they gain the Wind still more and more *Easterly*, but there is danger of not weathering the *Brazilian* shore, or at least the shoals upon that Coast.

But

But if upon the other tack they go away E. S. E, they fall into the neighborhood of the Coast of *Guinea*, from which there is no departing without running *Easterly*, as far as the *Isle of St. Thomas*, which is the constant practise of all the *Guiny* Shippes, and which may seem very strang without the consideration of the sixth remark, which shews the reason of it. For being in with the Coast, the Wind blows generally at S. W. and W. S. W, with which Winds they cannot go to the *Northward* for the Land, and on the other tack they can lie no nearer the Wind than S. S. E. or *South*; with these courses they run off the shore, but in so doing they alwaies find the *Winds* more and more contrary; so that when near the shore they could lie *South*, at a greater distance they can make their way no better than S. E. and afterwards E. S. E, with which courses they fetch commonly the *Isle of St. Thomas* and *Cape Lopez*, where finding the Winds to the *Eastward* of the *South*, they keep them favourable by running away to the *Westward* in the *South Lat.* of 3 or 4 degrees, where the S. E. Winds are perpetual.

For the sake of these general *Winds*, all those that use the *West-Indian Trade*, even those bound to *Virginia*, count it their best course to get as soon as they can, to the *Southwards*, that so they may be certain of a fair and fresh gale to run before it to the *Westwards*; and for the same reason those homewards bound from *America*, endeavour to gain the *Latitude* of 30 degrees, as soon as possible, where they first find the Winds begin to be Variable; though the most ordinary Winds in the *Northern* part of the *Atlantick Ocean* come from between the *South* and *West*.

As to those furious stormes called *Hurricanes*, which are as it were peculiar to the *Caribbe Isles*; and which so dreadfully afflict them in the month of *August*, or not much before or after, they do not so properly belong to this place, both by reason of their small continuance and extent, as likewise because they are not Anniversary, some years having more than one, and sometimes for several years together

ther there being none at all. But their Violence is so unconceivable, and their other *Phænomena* so surprizing, that they merit well to be considered apart.

What is here said, is to be understood of the *Sea Winds* at some distance from the Land; for upon and near the shores, the Land and Sea Brizes are almost every where sensible; and the great Variety which happens in their Periods, Force and Direction, from the situation of the Mountains, Vallies and Woods, and from the various texture of the Soil, more or less capable of retaining and reflecting Heat, and of exhaling or condensing Vapours is such, that it were an endless task, to endeavour to account for them.

II. In the *Indian Ocean*, the Winds are partly General, as in the *Æthiopick Ocean*, partly Periodical, that is half the Year they blow one way, and the other half near upon the opposite points; and these points and times of shifting are different in different parts of this Ocean; the limits of each tract of Sea, subject to the same change or *Monsoon*, are certainly very hard to determine, but the diligence I have used to be rightly informed, and the care I have taken therein, has in a great measure surmounted that difficulty, and I am perswaded that the following particulars may be relied upon.

1. That between the Latitudes of ten Degrees and thirty Degrees *South*, between *Madagascar* and *Hollandia Nova*, the General *Trade Wind* about the S. E. by E. is found to blow all the Year long, to all intents and purposes after the same manner as in the same Latitudes in the *Æthiopick Ocean*, as it is described in the *6th. Remark* aforegoing.

2. That the aforesaid S. E. Winds extend to within two Degrees of the *Equator*, during the Months of *June, July, August, &c. to November*, at which time between the *South Latitudes* of 3 and 10 Degrees, being near the *Meridian* of the North end of *Madagascar*, and between 2 and 12 *South Latitude*, being near *Sumatra* and *Java*, the contrary Winds from the N. W. or between the *North*
and

and *West*, set in and blow for half the Year, *viz.* from the beginning of *December* till *May*: and this *Monsoon* is observed as far as the *Molucca* Isles, of which more anon.

3. That to the *Northward* of 3 Degrees *South Latitude*, over the whole *Arabian* or *Indian-Sea* and *Gulph* of *Bengall*, from *Sumatra* to the *Coast* of *Africa*, there is another *Monsoon*, blowing from *October* to *April* upon the *North East* Points; but in the other half Year, from *April* to *October*, upon the opposite Points of *S. W.* and *W. S. W.* and that with rather more force than the other, accompanied with dark, rainy weather, whereas the *N. E.* blows clear; 'tis likewise to be noted, that the Winds are not so constant, either in strength or point, in the *Gulph* of *Bengall*, as they are in the *Indian-Sea*, where a certain steady Gale scarce ever fails. 'Tis also remarkable, that the *S. W.* Winds in these Seas are generally more *Southerly* on the *African* side, more *Westerly* on the *Indian*.

4. That as an *Appendix* to the last described *Monsoon*, there is a Tract of Sea to the *Southwards* of the *Equator*, subject to the same changes of the Winds, *viz.* near the *African-Coast*, between it and the Island *Madagascar* or *St. Laurence*, and from thence *Northwards* as far as the *Line*: wherein from *April* to *October* there is found a constant fresh *S. S. W.* Wind, which as you go more *Northerly*, becomes still more and more *Westerly*, so as to fall in with the *W. S. W.* Winds, mentioned before, in those Months of the Year to be certain to the *Northward* of the *Equator*: What Winds blow in these Seas, for the other half Year, from *October* to *April*, I have not yet been able to obtain to my full satisfaction, for that our Navigators always return from *India* without *Madagascar*, and so are little acquainted in this matter; the Account has been given me is only this, that the Winds are much *Easterly* hereabouts, and as often to the *North* of the true *East* as to the *Southwards* thereof.

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5. That to the *Eastward* of *Sumatra* and *Malacca*, to the *Northwards* of the *Line*, and along the *Coast* of *Camboia* and *China*, the *Monsoons* blow *North* and *South*, that is to say, the *N. E. Winds* are much *Northerly*, and the *S. W.* much *Southerly*: This *Constitution* reaches to the *Eastwards* of the *Philippine-Isles*, and as far *Northerly* as *Japan*. The *Northern Monsoon* setting in, in these Seas, in *October* or *November*, and the *Southern* in *May*, blowing all the *Summer Months*: Here it is to be noted, That the *Points* of the *Compass*, from whence the *Wind* comes in these *Parts* of the *World*, are not so fixt as in those lately described; for the *Southerly* will frequently pass a *Point* or two to the *Eastwards* of the *South*, and the *Northerly* as much to the *Westwards* of the *North*, which seems occasioned by the great quantity of *Land* which is interspersed in these Seas.

6. That in the same *Meridians*, but to the *Southwards* of the *Equator*, being that *Tract* lying between *Sumatra* and *Java* to the *West*, and *New Guinea* to the *East*, the same *Northerly* and *Southerly Monsoons* are observed, but with this difference, that the inclination of the *Northerly* is towards the *N. W.* and of the *Southerly* towards the *S. E.* but the *plage venti* are not more constant here than in the former, viz. variable 5 or 6 *Points*; Besides the times of the *Change* of these *Winds*, are not the same as in the *Chinese Seas*, but about a *Month* or six *Weeks* later.

7. That these contrary *Winds* do not shift all at once, but in some places the time of the change is attended with *Calms*, in others with variable *Winds*; and it is particularly remarkable, that the *End* of the *Westerly Monsoon* on the *Coast* of *Coromandel*, and the two last *Months* of the *Southerly Monsoon* in the Seas of *China*, are very subject to be tempestuous: The violence of these storms is such, that they seem to be of the nature of the *West-India Hurricanes*, and render the *Navigation* of these parts

parts very unsafe about that time of the Year. These Tempests are by our Seamen usually termed, *The breaking up of the Monsoons*.

By reason of the shifting of these Winds, all those that sail in these Seas, are obliged to observe the seasons proper for their Voyages, and so doing they fail not of a fair wind and speedy passage; but if so be they chance to out-stay their time, till the contrary *Monsoon* set in, as it frequently happens, they are forced to give over the hopes of accomplishing their intended Voyages, and either return to the port from whence they came, or elce put in to some other Harbour, there to spend the time till the Winds shall come favourable.

III. The third Ocean called *Mare Pacificum*, whose extent is equal to that of the other two, (it being from the West Coast of *America* to the *Philippine* Islands, not less than 150 degrees of Longitude) is that which is least known to our own or the neighbour Nations; that Navigation that there is on it, is by the *Spaniards* who go yearly from the Coast of new *Spain* to the *Manilla's*, but that but by one beaten track; so that I cannot be so particular here as in the other two. What the *Spanish* Authors say of the Winds they find in their Courses, and what is confirmed by the old Accounts of *Drake* and *Candish*, and since by *Schooten*, who sailed the whole breadth of this Sea in the Southern Latitude of 15 or 16 degrees, is, that there is a great conformity between the Winds of this Sea, and those of the *Atlantick* and *Æthiopick*; that is to say, that to the Northwards of the *Equator*, the predominant Wind is between the *East* and *North-East*, and to the *Southwards* thereof there is a constant steady gale between the *East* and *South-East*, and that on both sides the *Line* with so much constancy, that they scarce ever need to attend the Sails, and strength, that it is rare to fail of crossing this vast Ocean in ten weeks time, which is about 13 miles *per diem*; besides 'tis said that Stormes and Tempests are never known in these parts: So that here is the ve-

ry best of Sailing; no want of a fresh fair Wind, and yet no danger of having too much: Wherefore some have thought it might be as short a Voiage to *Japan* and *China*, to go by the Streights of *Magellan*, is by the *Cape of Good-hope*.

The limits of these General Winds are also much the same as in the *Atlantick* Sea, viz. about the 30th. degree of Latitude on both sides; for the *Spaniards* homewards bound from the *Manilha's*, alwaies take the advantage of the Southerly *Monsoon*, blowing there in the Summer months, and run up to the *Northwards* of that Latitude, as high as *Japan*, before they meet with variable Winds, to shape their course to the *Eastwards*. And *Schooten* and others that have gon about by the *Magellan* Streights, have found the limits of of S. E. Winds, much about the same Latitude to the *Southwards*; besides a farther *Analogy* between the Winds of this Ocean, and the *Ethiopick*, appears in that, upon the Coast of *Peru*, they are alwaies much *Southerly*, like as they are found near the Shores of *Angola*.

Thus far matter of Fact, wherein if the information I have received be not in all parts Accurate, it has not been for want of inquiry from those I conceived best able to instruct me; and I shall take it for a very great kindness if any Master of a Ship, or other person, well informed of the Nature of the Winds, in any of the aforementioned parts of the World, shall please to communicate their Observations thereupon; that so what I have here collected may be either confirmed or amended, or by the addition of some material Circumstances enlarged. It is not the work of one, nor of few, but of a multitude of Observers, to bring together the experience requisite to compose a perfect and compleat History of these Winds; however I am not much doubtful that I have erred in, or omitted any of the principal Observables, whatever lesser particulars may have escaped my knowledg.

To help the conception of the reader in a matter of so much difficulty, I believed it necessary to adjoyn a Scheme, shew-

shewing at one view all the various Tracts and Courses of these Winds; whereby 'tis possible the thing may be better understood, than by any verbal description whatsoever.

The limits of these several Tracts, are designed every where by prickd lines, as well in the *Atlantick* and *Æthiopick*, where they are the boundaries of the Trade and Variable Winds, as in the *Indian* Ocean, where they also shew the extent of the several *Monsoons*. I could think of no better way to design the course of the Winds on the Mapp, than by drawing rows of stroaks in the same line that a Ship would move going alwaies before it; the sharp end of each little stroak pointing out that part of the Horizon, from whence the Wind continually comes; and where there are *Monsoons* the rows of the stroaks run alternately backwards and forwards, by which means they are thicker there than elsewhere. As to the great South Sea, considering its vast extent, and the little Variety there is in its Winds, and the great *Analogy* between them, and those of the *Atlantick* and *Æthiopick* Oceans, besides that the greatest part thereof is wholly unknown to us; I thought it unnecessary to lengthen the Mapp therewith.

In the foregoing History are contained several Problems, that Merit well the consideration of our acuteſt Naturaliſts, both by reason of the constancy of the effect, and of the immense extent thereof; near half the surface of the Globe being concerned. The chief of these Problems are. 1. Why these Winds are perpetually from the East in the *Atlantick* and *Æthiopick*, as likewise in the *Pacifick* Ocean, between the Latitudes of 30 North and South. 2. Why the the said Winds extend no farther with Constancy than to the Latitudes of 30th deg. 3. Why there should be a constant South-westerly Wind upon and near the Coast of *Guinea*. 4. Why in the North part of the *Indian* Ocean the Winds, which for one half year do agree with those of the other two Oceans, should change in the other half Year, and blow from the opposite Points; whilst the Southern part of that Ocean follows the

General Rule, and has perpetual Winds about S. E. 5. Why in these General Trade-Winds it should be alwaies true, that to the Northward of the *Equator* it is enclined to the Northwards of the East; and in South Latitudes, to the Southward thereof. 6. Why in the Seas of *China* there should be so great an Inclination from the East to the North, more than elsewhere; with many more, which it would be much easier to propose than Answer.

But least I should seem to propose to others, difficulties which I have not thought worth my own time and Paines, take here the result of an earnest endeavour after the true reason of the aforesaid *Phanomena*, wherein if I am not able to account for all particulars, yet 'tis hoped the thoughts I have spent thereon, will not be judged wholly lost, by the curious in Natural Inquiries.

Wind is most properly defined to be the Stream or Current of the Air, and where such Current is perpetual and fixt in its course, 'tis necessary that it proceed from a permanent unintermitting Cause. Wherefore some have been enclined to propose the diurnal *Rotation* of the Earth upon its *Axis*, by which, as the *Globe* turns Eastwards; the loose and *fluid* particles of the Air, being so exceeding light as they be, are left behind, so that in respect of the Earths *surface* they move Westwards, and become a Constant Easterly Wind. This opinion seems confirmed, for that these Winds are found only near the *Equinoctial*, in those *Parallels* of Latitude where the diurnal Motion is swiftest; and I should readily assent to it, if the constant Calms in the *Atlantick* Sea, near the *Equator*; the Westerly Winds near the Coast of *Guiny*; and the *Periodical* Westerly *Monsoons* under the *Equator* in the *Indian* Seas, did not declare the insufficiency of that *Hypothesis*. Besides the Air being kept to the Earth by the principle of *Gravity*, would acquire the same degree of *Velocity* that the Earths *surface* moves with, as well in respect of the diurnal *Rotation*, as of the Annual about the Sun, which is about thirty times swifter.

It

It remains therefore to substitute some other cause, capable of producing a like constant effect, not liable to the same Objections, but agreeable to the known properties of the Elements of Air and Water, and the laws of the Motion of fluid Bodies. Such an one is, I conceive, the Action of the Suns Beams upon the Air and Water, as he passes every day over the Oceans, considered together with the Nature of the Soyl, and Scituation of the adjoyning Continents: I say therefore, first that according to the Laws of *Statics*, the Air which is less rarified or expanded by heat, and consequently more ponderous, must have a Motion towards those parts thereof, which are more rarified, and less ponderous, to bring it to an *Equilibrium*; and secondly, that the presence of the Sun continually shifting to the Westwards, that part towards which the Air tends, by reason of the Rarification made by his greatest *Meridian* Heat, is with him carried Westward, and consequently the tendency of the whole Body of the lower Air is that way.

Thus a general Easterly Wind is formed, which being impressed upon all the Air of a vast Ocean, the parts impel one the other, and so keep moving till the next return of the Sun, whereby so much of the Motion as was lost, is again restored, and thus the Easterly wind is made perpetual.

From the same Principle it follows, that this Easterly Wind should on the North Side of the Equator, be to the Northwards of the East, and in South Latitudes to the Southwards thereof; for near the *Line*, the Air is much more rarified, than at a greater distance from it; because of the Sun twice in a year Vertical, and at no time distant above 23dg. and a half, at which distance the heat, being as the Sine of the Angle of Incidence, is but little short of that of the perpendicular Ray. Whereas under the Tropicks, though the Sun stay long Vertical, yet he is as long 47dg. off; which is a kind of Winter, wherein the Air so cools, as that the Summer Heat cannot warm it to the same Degree with that under the Equator. Wherefore the Air to the North-wards

wards and Southwards, being less rarified than that in the middle, it follows, that from both sides it ought to tend towards the *Equator*: This Motion compounded with the former Easterly Wind answers all the *Phænomena* of the general Trade Winds, which if the whole surface of the Globe were Sea, would undoubtedly blow all round the World, as they are found to do in the *Atlantick* and *Æthiopic* Oceans.

But seeing that so great Continents do interpose and break the continuity of the Oceans, regard must be had to the Nature of the Soil, and the position of the high Mountains, which I suppose the two principal Causes of the several Variations of the Winds, from the former general Rule: for if a Country lying near the Sun, prove to be flat, sandy, low Land, such as the Desarts of *Lybia* are usually reported to be, the heat occasioned by the reflection of the Suns Beams, and the retention thereof in the Sand, is incredible to those that have not felt it; whereby the Air being exceedingly rarified, it is necessary that this cooler and more dense Air should run thitherwards to restore the *Æquilibrium*: This I take to be the cause, why near the Coast of *Guinea* the Wind always sets in upon the Land, blowing Westerly instead of Easterly, there being sufficient reason to believe, that the Inland Parts of *Africa* are prodigiously hot, since the Northern borders thereof were so intemperate, as to give the Ancients cause to conclude, that all beyond the *Tropick* was made inhabitable by excess of heat: From the same cause it happens, that there are so constant Calms in that part of the Ocean, called the *Raines*. (described in the 7th. Remark on the *Atlantick* Sea) for this Tract being placed in the middle, between the Westerly Winds blowing on the Coast *Guinea*, and the Easterly Trade-Winds, blowing to the Westwards thereof, the tendency of the Air here, is indifferent to either, and so stands in *Æquilibrium* between both; and the weight of the incumbent Atmosphere being diminished by the continual contrary Winds blowing from hence, is the reason
that

that the Air here holds not the copious Vapour it receives, but lets it fall in so frequent Rains.

But as the cool and dense Air, by reason of its greater Gravity, presses upon the hot and rarified, 'tis demonstrative that this latter must ascend in a continued stream as fast as it Rarifies, and that being ascended, it must disperse it self to preserve the *Æquilibrium*; that is, by a contrary Current, the upper Air must move *from* those parts where the greatest Heat is: So by a kind of Circulation, the North-East Trade Wind below, will be attended with a South Westerly above, and the South Easterly with a North West Wind above; that this is more than a bare conjecture, the almost instantaneous change of the Wind to the opposite Point, which is frequently found in passing the limits of the Trade Winds, seems to assure us; but that which above all confirms this *Hypothesis* is the *Phenomenon* of the *Monsoons*, by this means most easily solved, and without it hardly explicable.

Supposing therefore such a Circulation as above, tis to be considered that to the Northward of the *Indian* Ocean there is every where Land within the usual limit of the Latitude of 30. viz. *Arabia. Persia, India &c.* which for the same reason as the *Mediterranean* Parts of *Africa*, are subject to unsufferable heats when the Sun is to the North, passing nearly Vertical; but yet are temperate enough when the Sun is removed towards the other *Tropick*; because of a ridge of Mountains at some distance within the Land, said to be frequently in Winter covered with Snow, over which the Air, as it passes, must needs be much chilled. Hence it comes to pass, that the Air coming according to the general Rule, out of the *N. E.* in the *Indian* Seas, is sometimes hotter, sometimes colder, than that which by this Circulation is returned out of the *S. W.* and by consequence, sometimes the under Current or Wind is from the *N. E.* sometimes from the *S. W.*

That

That this has no other cause, is clear from the times wherein these Winds set in: *viz.* in *April*, when the Sun begins to warm those Countries to the North, the S. W. *Monsoon* begins, and blows during the Heats till *October*; when the Sun being retired, and all things growing cooler Northward, and the Heat encreasing to the South, the North-East Winds enter and blow all the winter till *April* again. And it is undoubtedly from the same Principle that to the Southwards of the *Equator*, in part of the *Indian Ocean*, the North-West Winds succeed the South-East, when the Sun draws near the *Tropick of Capricorn*; but I must confess, that in this latter occurs a difficulty, not well to be accounted for, which is, why this Change of the *Monsoons* should be any more in this Ocean, than in the same Latitudes in the *Aethiopic*, where there is no thing more certain than a S. E. Wind all the Year.

'Tis likewise very hard to conceive why the limits of the Trade Wind should be fixt, about the thirtieth degree of Latitude all round the Globe; and that they should so seldom transgress or fall short of those bounds; as also that in the *Indian Sea*, only the Northern Part should be subject to the changeable *Monsoons*, and in the Southern there be a constant S. E.

These are particulars that merit to be considered more at Large, and furnish a sufficient Subject for a just Volume; which will be a very commendable Task for such, who being used to Philosophick Contemplation, shall have leasure to apply their serious thoughts about it.

A Dioptrick Problem, Why four Convex-glasses in a Telescope, shew Objects Erect. by William Molineux of Dublin Esq. R. S. Soc.

IN the *Journal des Sçavans* for Munday the 17th. of September 1685. pag. 466. Amst. Edition, we find this passage. *As Perspectives of one Convex-glass make Objects appear Upright, which those of two Convex-glasses invert, and again those of three rectify; so it should seem that those of four ought to invert: And yet Experience shews us that Objects appear upright through these glasses. The Singularity of this Phænomenon obliges all Skil'd in Dioptricks to inquire the reason thereof, but hitherto they have found none. Mr. Regis, who applies himself particularly to this part of Natural Philosophy, beleives that he has hit upon the Reason, and makes us hope that he will suddenly Publish it.*

Thus far the *Journal*, but it does not tell us whose remark this is, though I am apt to beleive 'twas written by Mr. Regis himself, to the Publisher of the *Journal*.

To me this *Phænomenon* appears very easily explicable, from the consideration of placing Glasses in a Tube. Which is thus; after the *Object-glass*, the *Eye-glass* is placed so much distant (towards the Eye) from the *Focus* of the *Object-glass* as is the *Focus* of the *Eye-glass*; then the middle *Eye-glass* is placed so much distant from the *Focus* of the first *Eye-glass*, as is the *Focus* of this middle *Eye-glass*; lastly the nearest *Eye-glass* is placed so much distant from the *Focus* of this middle *Eye-glass*, as is the *Focus* of this nearest *Eye-glass*; and the Eye looking through them all is placed in the *Focus* of this nearest *Eye-glass*.

I say therefore first, that one single Convex-glass, cannot properly be said by it self to shew Objects erect or reverse, but in respect of placing of the Eye that looks through it. For if the Eye that looks through such a single Convex-glass

be placed nigher thereto, then the Glasses *Focus*, the Objects are erect, if the Eye be placed just in the *Focus*, the Objects are neither erect nor reversed, but all in confusion between both; and if the Eye be placed further from the Glass than the *Focus*, the Objects are reversed. I mean here distant Objects, the Rays flowing from any point whereof may be counted to come parallel towards the *Object-glass*, for such Objects we are to consider when we speak of looking thro' *Telescopes*.

This being laid down, I assert. Secondly, that the *Object-glass* of a Telescope reverses the Object, both to the *Eye-glass* and the Eye, that looks through it; For the *Eye-glass* is placed farther from the *Object-glass* than is the *Focus* of the *Object-glass*. But the *Eye-glass* does nothing towards the Rectification or Reversion; the Eye being placed just in it's *Focus*. Thus we see that the Reversing of Objects in a *Telescope* of two Convex-glasses proceeds wholly from the *Object-glass* and its position, and the *Eye-glass* has nothing to do in the *Affaire*; for were the Eye it self in the place of the *Eye-glass* it would see the Objects inverted thro' the single *Object-glass*.

I come now to consider the second *Eye-glass* placed after the first *Eye-glass*. (the first *Eye-glass* being that next the *Object-glass*) And here it is manifest that placing this as it ought in a *Telescope*, if we place our Eye nearer to this middle *Eye-glass* than it's *Focus*, the Eye sees the Objects inverted and confused: Place the Eye in the *Focus*, it sees the Objects all in confusion, neither erect nor reversed; for here again there is a distinct Representation of the Objects to be received on a piece of Paper, as in the *Focus* of the *Object-glass*; and the Eye being placed at any time at this place (which is usually called the *Distinct-Base*) sees all in confusion. But then let the Eye be placed farther from this middle Glass than its *Focus* (for so is the third or immediate *Eye-glass*, it being alwayes distant from the middle *Eye-glass*, the Aggregate of both their *Foci*) it perceives the Objects erect and confused.

Last-

Laſtly. the third or immediate *Eye-glaſs* does nothing towards the erecting or reverſing the Species, which it receives erect from the middle *Eye-glaſs*; no more than in a Telescope of two Convex-glaſſes, the *Eye-glaſs* does to the Species it receives from the *Object-glaſs*, as we have ſhewn before. The reaſon that this laſt or immediate *Eye-glaſs* has nothing to do in the erecting or reverſing the Species is the ſame, as in a Telescope of two Convex-glaſſes, *viz.* the Eye is placed in its *Focus*, and therefore ſees the Species as 'tis represented in the *Diſtinct Baſe*; that is, the Species is inverted in the *Diſtinct Baſe* of the *Object-glaſs*, and therefore a ſingle Convex *Eye-glaſs* brings it to the Eye inverted; but in the *Diſtinct-Baſe* of the middle or ſecond *Eye-glaſs* the Species is erect, and therefore the third or immediate *Eye-glaſs* brings it to the Eye erect.

Wherefore we are to conſider the Telescope conſiſting of an *Object-glaſs* and three *Eye-glaſſes*, as two Telescopes, each conſiſting of two Convex-glaſſes. The firſt conſiſts of the *Object-glaſs* and firſt *Eye-glaſs*; and this inverts the Species; that is, the Species is inverted in the *Diſtinct-Baſe* of the *Object-glaſs*, and ſo brought into the Eye. The ſecond Telescope conſiſts of the two immediate *Eye-glaſſes*, and this erects what the former inverted, that is, the Species in the *Diſtinct-Baſe* of the middle *Eye-glaſs* is erect, and is ſo brought into the Eye by the *Eye-glaſs*; the *Eye-glaſſes* themſelves in neither caſe having any thing to do with the erecting or inverting, but meerly in representing in the ſame poſture the Species immediatly before them.

The *French Problem* therefore ſhould not have broken a Telescope of four Convex-glaſſes into four peices, but into two, and the caſe would have been plain; whereas by breaking it into four *Perspective-Glaſſes*, they attribute that to two of them, which neither of them does, *viz.* inverting and erecting.

Therefore I ſay laſtly, that one Convex-glaſs as poſited in a Telescope inverts, the ſecond (that is the firſt *Eye-glaſs*)
X 2 does

does nothing towards erecting or reverſing, but repreſents the Image as it is in the *Diſtinct-Base* of the *Object-glaſs* before it, that is, inverted. The third Glaſs erects, or rather reſtores what was before inverted. The fourth repreſents the Image as it receives it from the *Diſtinct-Base* of the third, that is, erect. And this I think a ſufficient Solution of this Problem.

An uncommon Inſcription lately found on a very great Baſis of a Pillar, dug up at Rome; with an Interpretation of the ſame by the learned Dr. Voſſius.

THIS Inſcription was ſent by that excellent Philoſopher and Mathematician Mr. *Adrian Auzout*, who copyed it from the Stone, to Mr. *Juſtel*, who was pleaſed to communicate it to the *Royal Society*, together with the Sentiments of Dr. *Voſſius* thereupon, of which the Reader may Judg.

The Inſcription is three fold upon three ſides of the Baſis, and as follows.

P. SVFENATI. P. F. PAL. MYRONI
 EQVITI. ROMANO. DECV
 RIALI. SCRIBARVM. AEDILI
 VM. CVRVLIVM. LVPERCO. LAVRENTI
 LAVINATI. FRETRIACO. NEAPOLI. ANTI
 NOITON. ET. EVNOSTIDON. DE
 CVRIONI. IIII, VIRO. ALBA

NI.

NI. LONGANI. BOVILLEN
SES. DECVRIONES OB ME
RITA. EIVS. L. D. D. D

P. SVFENATI. P. F.
PAL. SEVERO. SEMPRO
NIANO. DECVRIALI
SCRIBARVM. AEDILIVM. CVRV
LIVM. FRETRIACO. NEAPOLI. EV
NOSTIDON. DECVRIONI. ET
SA. ERDOTI. APOLLI
NIS. ALBANI. LONGA
NI. BOVILLENSES. DE
CVRIONES. OB. MERI
TA. SVFENATIS. HER
METIS. PATRIS. EIVS
L. D. D. D.

P. SVFENATI. P. F. -- --
MYRONI.
EQVITI. ROMANO. DEC ---

ALI. SCRIBARVM. AED ---

CVRVLIVM. LVPERCO ---

TI. LAVINATI. FRETRIAC --

APOLI. ANTINOITON ---

NOSTIDON. DECVR ---

III. VIRO. ALBANI ---

GANI. BOVILLEN:--

MVNICIPES. OB.

EIUS. L...D.-----

An Extract of the Letter of Dr. *Vossius* to Mr. *Iustel*
upon the Subject of this Inscription.

— Bene nosti classem Ægyptiacam sive Cataplum Alexandrinum antequam portus Ostiæ esset exstructus, singulis Annis appulisse Puteolos, unde demum frumentum Romam deferrebat. Postquam vero Augustus, & Claudius Cæsares & postea Nero Ostiæ portum aperuerunt, jam annona non tantum Puteolos sed & longe maxima sui parte Ostiam appetebat. Constat autem tempore Tiberii pulsos Roma fuisse Judæos & Ægyptios; unde factum est ut ab Ostia per agrum Laurentem deportaretur frumentum Ariciam et Albam longam usque ad Bovillas, ad decimum nempe ab Urbe Lapidem; neque enim longius progredi permittebatur. A Bovillis enim Romam per Institores Romanos deferrebat, neque enim Ægyptiis aut Judæis in Urbe habitare aut horrea habere erat licitum. Mensuris vero & Venditoribus frumenti Ostiæ & passim alibi præfuisse Decuriones & hoc quoque ex jure constat Sed vero omnibus istis minoribus Decurionibus, qui in singulis locis & Urbibus frumenti curam haberent, præfuisse alium Decurionem

niem, qui vicem Praefecti Annonae obiret, & in omnibus istis inferiorum Decurionum Collegiis primum teneret locum, id manifeste ex hac patet Inscriptione, ubi minores Decuriones Bovillani honorem faciunt Equiti Romano & Palatino, qui Decurio seu Curialis & Fretriacus in omnibus esset locis & urbibus, a quibus & per quas Annona Aegyptiaca Romam debebatur. Decuriones vero promotos fuisse ad honorem Sacerdotii, ita ut simul Flamines, Luperci, Epulones Jovis, & Parasiti fierent Apollinis; & hoc quoque multis constat exemplis. Omne vero dubium tollit, quod in hac Inscriptione eques ille Romanus vocetur Antinoiton & Eunostidon Decurio. Antinoi enim urbs praecipua tum temporis Aegypti superioris erat Civitas, unde per multas fossas frumentum deferrebatur ad Mareotin lacum, qui ad Eunosti portum exit in Mare. Ab hoc portu dicti Eunostidae curatores frumenti Aegyptiaci; unde demum confectus deus Eunostus rei frumentariae Inspector, qui huic praesideret portui.

Several Observations of the Eclipse of Jupiter by the Moon on March the 31th. 1686. St. Vet. whereof some account has already been given in Transaction No. 181.

THe most accurate Observation of this Eclipse we have received, is that of Mr. Cassini, made in the Royal Observatory at Paris, published in the *Journal des Sçavans* of the 10th of June last, the substance whereof is as follows.

April 10th. St. N. Vesperis Mr. Cassini, assisted by other Astronomers, attended upon this Occultation with Telescopes of 21 and 70 foot, while one was deputed to take the Altitudes of γ to verifie the time.

At 9h. 31m. 6sec. γ was in a perpendicular falling on the Limb of the γ over against the Northern Part of the spot Grimaldi (Mareotis) near to Riccioli (stag. Miris) and was distant from the Limb about four times as much as the said spot.

9h.

9h. 4^m. 21^{sec}. γ touched the circumference of δ , which undulated by reason of the Vapours near the Horizon.

9. 41. 20. he quite disappeared in the inequalities of the δ 's Limb, the total Immersion might be some seconds later.

So the central immersion was at 9h. 40^m. 51^{sec}.

γ entred over against that part of *Grimaldi* next *Riccioli*. The Vapeurs of the Horizon hindered the Observation of the Immersions of the Satellites, but not their Emersions, for

At 10h. 30^m. 2^{sec}. the *outermost* Satellite which preceded γ , appeared over against the middle of the Caspian Spot (*pal. Maotis*) through which the section of Light and Darkness passed, and made nearly an equilateral Triangle with the Extremities of that spot.

At 10h. 40^m. 24^{sec}. the first Limb of γ began to come out of the dark side of the δ , over against the North part of the Caspian spot, about Cleomedes, (*ad montes Rhipaeos*)

At 10h. 40^m. 56^{sec}. the center of γ did emerge. It was difficult to distinguish the moment when γ 's disk was fully clear, but at 10h. 41^m. 36^{sec}. the Eclipse was certainly past.

At the Emersion of the Center, the Altitude of γ was 11^d. 31^m.

At 10h. 42^m. 49^f, the *second* Satellite, being the nearest of the three that followed the Planet, emerged.

At 10h. 45^m. 1^f. the *innermost* Satellite, being near its greatest Elongation, emerged.

At 10h. 50^m. 40^f. the *third* or *penextimus* Satelles, being likewise near its greatest Elongation, began to appear over against the Northern Edge of the Caspian Spot.

At 11h. 45^m. the Diameter of the δ was 32^m. 27^f. and according to the *calculus* of Mr. *Cassini*, her parallax was 6^{min}.

Together with this Observation is joyned that of R. P. *Bonfa*. made at *Avignon* who observed the central immersion at 9h. 42^m. 12^f. and the central Emersion at 10h. 45^m. 2^f. over

over against the Southern part of the Caspian Spot.

The same *P. Bonfa* has also observed at *Avignon* the other Eclipse of the same Planet, *April 28th. st. vet. Mane.* The Immersion of the Center hapned at *3h. 37m. 23s.* on the East side of the Spot *Xenophanes.* The Emerfion was at *4h. 28m. 2s.* between *Seneca* and *Berosus*, according to *Riccioli*, or *ad montes Alanos Hevelii*, a little to the Northward of the *Palus Maotis.* This occultation could not be observed at *Paris* by reason of Clouds.

Another printed Paper about the Eclipse of *March 31th*, is since come to hand from *Nurenburg*, where it was observed part, by *Mr. I. Iac Zimmerman*, and by *Mr. Wurtzelbauer*, the substance of whose Observations is as follows.

At *10h. 19m. 56s.* *Mr. Zimmerman* observed the first contact of the Limbs of γ and the δ , and at *10h. 20m. 47s.* γ was all eclipsed.

At *11h. 22m. 51s.* γ was wholly clear from the Eclipse.

The Immersion was about the *117th*, the Emerfion at the *321th.* Degree of the Limb, in the Chart of *Hevelius.*

At *11h. 31m. 06s.* the third Satellite of γ emerged. These times were collected from the Culminations of fixt Stars, and the Vibrations of a Pendulum.

The Relation of the other Observer *Mr. Wurtzelbauer* is to this purpose.

At *10h. 20m. 50s.* γ applyed to the Limb of the δ , over against the *loca paludosa Insulae Circinnae.*

At *10h. 22m. 00s.* he appeared about half eclipsed.

At *10h. 22m. 30s.* he was wholly hid.

At *11h. 19m. 40s.* γ began to Emerge.

At *11h. 21m. 20s.* he was quite free from the interposition of the δ . The point of the Emerfion was somewhat to the North of the *Palus Maotis.*

No Spot in the δ was so near the apparent magnitude of γ 's disk as the *Insula Besbicus Hevelii.*

At *11h. 40m. 00s.* the Altitude of *Procyon* was *8gr. 37m.* whence the Pendulum Clock, which had been set by Altitudes

tudes of the ☉ the afternoon preceding, may be examined.

The Account we have but now lately received from the famous Mr. *Hevelius* from *Dantzick*, of these same Eclipses, is contained in this following Discourse addressed in a Letter from the Observer to the *R. Society*.

Occultatio Jovis Anno 1686, die 10 April. st. n. vesperi, observata Gedani a Joh. Hevelio.

AD hanc Observationem summa alacritate accessi, non obstante invaletudine mea, cum Cœlum fere undeq; esset serenum, nisi quod circa Horizontem, ubi Luna atq; Jupiter exoriri debebant, vapores quidam atq; nubeculæ existerent. Inprimis ex eo maximopere fui excitatus, quod hujus generis Observationes, Occultationes nempe Jovis admodum raro contingant, sed adhuc rarius ex voto observentur. Me quod attinet, scias, mi Lector, etiamsi hucusq; per 56 annos Rebus Cœlestibus pro meo modulo operam dederim, atq; nullam Observationem alicujus momenti, (absit gloriola) lubens neglexerim, haud feliciorem fuisse quam quod in hunc usq; diem spatio 50 circiter annorum, non nisi tres tales Jovis Eclipses rite deprehendere & annotare potuerim: utpote primam Anno 1646, die 24 Decemb. vesperi, sed tantummodo ejus finem: secundam, Anno 1679, die 5 Junii ante meridiem de die, quo tempore res omnis felicius successit; tertiam hoc Anno currente 1686 die 10. April. vesperi.

Quam Observationem, mi Astrophile, prout peragi potuit, a me nunc benevole accipias, rogo. Quæ vero obtenta, atq; annotata fuerunt, ex subsequente Tabella & Observationis Typo patebunt. Omnium primo nonnullas Altitudines Solis, & Arcturi Quadrante singula minuta commostrante observavi, ad corrigendum Horologium ambulatorium aliquanto tardius incedens. Deinde, exoriente atq; ex
nu.

nubeculis circa Horizontem vagabundis erumpente Luna ac Jove, nonnullas Distantias a limbo Lunæ orientali cepi, ea ratione, qua tum licuit meliori. Inter alia autem notandum occurrit, quod hæcce Occultatio non Luna omnino existente plena, sed altera die circiter post ipsum Plenilunium vesperi acciderit; & quidem eodem tempore (quod permirum sane accidit, & est casus, qualis haud facile unquam continget) eademq; facie, ut illa Occultatio Anni 1646 die 24 Decemb. vesperi visa est; quo tempore Luna jam ad biduum pariter decreverat, & sine dubio eandem Librationem etiam exhibuit, quam in hac nostra ultima Observatione. Nam Sectio Luminis atq; umbræ plane fuit eadem, & per easdem maculas transiit (quod satis admirari nequeo) nimirum ad Lacum Hyperboreum majorem & minorem, tum ad montes Riphæos, per paludem Mæotidem, per Lacum majorem maris Caspii, & finum ejus inferiorem ad Montem Nerosum.

E contrario, Jovis Occultatio Anno 1679 a me habita, plane extitit diversa, siquidem illa non circa Plenilunium, sed Novilunium accidit, tertia circiter die ante Conjunctionem ipsam, adeo ut phasis tantummodo parvula decrescens conspecta sit, instar Phaseos mæ Lunæ cornutæ decrescens, sub Numero 37, in mea Selenographia, pag. 402 conspicuæ: transibat enim per finum Apollinis, per loca paludosa Insulæ Cercinnæ, Mare Syrticum, Montem Cataractes, & partem inferiorem Sin. Sirbonis, montemq; Lion: prout ex ipso schemate dictæ Occultationis An. 1679, in Anno meo Climacterico pag. 38. clare liquet.

Postquam itaq; initio, ut supra dicebam, nonnullas Distantias Jovis a limbo Lunæ Orientali ceperam, atq; Jupiter magis magisque Lunæ appropinquaret, omni diligentia invigilavi, ut non solum quam accuratissime ipsum momentum temporis annotarem, quando Jupiter prius Limbo suo occiduo limbum Lunæ orientalem attingeret, sed etiam quando dimidiis, nec non quando omnino totus esset tectus. Hæc etenim recte scire Astronomiæ plurimum interest; præfer-

tim, cum a nemine Observatorum hucusq; nondum, quantum sciem, adhuc sit deprehensa. An in hac Observatione a quopiam sint annotata, adhuc me latet; tempus tamen docebit.

Me quod attinet, hæc omnia ex voto obtinui, non solum circa initium, sed etiam circa finem hujus Occultationis, sic ut ipsum momentum temporis rursus primæ apparitionis Jovis occasum versus, ad Sectionem Luminis & Umbrae, nec non cum dimidiis, ut & totus appareret, exactissime deprehendere potuerim. His acquisitis Diametrum Lunæ optimo Micrometro, atq; Telescopio duodecim circiter pedum investigavi, pariter unam aut alteram Jovis Distantiam a confinio Lucis & umbrae, a parte scilicet Lunæ occidentali, pro majori confirmatione reliquarum Observationum, sicuti ex annexa Tabella atq; Observationis Typo elucet: quæ præmittenda esse duxi, antequam ad alia nonnulla bene notanda me conferam.

Eclipsis Jovis Observata GEDANI a Job. Hevelio
Anno. Æræ Christ. 1686. die 10 April. Vesp. st. n.

<i>Horologi. ambulator.</i>			<i>Altitudines Quadrante captae.</i>			<i>Tempus ex Altitud. cor rectum.</i>		
H.	M.	S.	Gr.	M.	S.	H.	M.	S.
5	10	10	Altitudo Solis.			5	11	43
5	12	30	Altitudo Solis.			5	13	55
5	17	4	Altitudo Solis.			5	19	21
5	23	50	Altitudo Solis.			5	25	43
8	7	1	Altitudo Arcturi.			8	12	50
8	11	15	Altitudo Arcturi.			8	17	4
8	15	1	Altitudo Arcturi.			8	20	51
Luna oritur			circit.			9	24	0
9	44	50	Jupiter ob nubes & vapores citius haud conspectus; distabat tum ab Ins. Cer- cinna 43 circit. minut.			9	52	50

Jovis

H. M. S.		H. M. S.
10 21 30	Jovis distantia erat tanta, quanta distantia M. Sinai a Palude Maræotide.	10 31 30
10 40 35	Jovis distantia erat fere æqualis distantiae inter M. Ætnam & M. Porphyritem.	10 51 5
10 51 30	Jovis limbus a limbo distabat tanto interstitio, quanto Pal. Maræotis a limbo	11 2 0
10 56 9	& limbo suo tangere incipiebat Lunæ limbum, atq; sic initium Occultationis	11 7 9
10 56 54	Dimidius Jupiter occultabatur. (accidit.	11 7 54
10 57 39	Totus Jupiter omnino a tectus.	11 8 39
11 8 31	Occultatio Comitis Jovis ultimi ad M. Alabastrinum accidit.	
	Duo tantummodo Comites a parte orientali conspecti sunt.	
11 15 44	Altitudo Lyrae.	32 59 0
11 19 0	Insula Besbicus & Rhodus reperiiebantur sub eodem perpendicularo; id quod ad 35gr. circ. a Linea verticali re-	11 26 0
11 21 37	Altitudo Lyrae. (movebatur.	33 50 0
11 24 57	Altitudo Lyrae.	34 24 0
11 38 15	Emerfionis initium Jovis.	11 32 15
11 39 0	Dimidius Jupiter emergebat.	11 36 24
11 39 45	Totus Jupiter apparebat.	11 49 15
	Diameter Lunæ Micrometro observata erat 31m. <i>sc.</i>	11 50 0
11 54 10	Distantia Jovis a confinio Lucis & Umbrae erat æqualis distantiae M. Ætnæ a M. Porphyrite.	11 50 45
11 57 20	Distantia Jovis a confinio Lucis & Umbrae elongabatur intervallo inter Insulam Besbic. & M. Ætnam. Et comes & remotissimus a Jove tantum aberat, quantum ipse comes a dicto confinio Lucis.	12 5 40
12 6 9	Altitudo Lyrae.	12 9 20
12 9 18	Eadem Altitudo denuo.	
12 13 20	Altitudo Lunæ.	
	40 19 0	12 18 39
	40 46 0	12 21 49
	16 15 0	

Primo liquidum est ex ipsa Observatione & occultationis Schemate, quod orbita, seu Linea Jovis itineraria, per Montem Alabastrinum, per M. Christi, M. Carpathes, infra M. Macrocmnios, & per Lacum Hyperborium inferiorem incesse- rit. Secundo, quod Insula Besbica & Insula Rhodus sub uno eodemq; perpendicularo, tempore occultationis, hora circiter 1^m. 30 extiterit; sic ut 35 gradus Lunæ limbi culminaverit. Intravit itaq; Jupiter limbum Lunæ illuminatum circa 61 gradum, a linea scilicet perpendiculari Nonagesimi atq; puncto Zenith, ortum versus; exivit vero circa 31 gradum a dicta linea perpendiculari Nonagesimi occasum versus, ad limbum Lunæ obscuratum. Proinde Linea Jovis itineraria fuit subtensa 104 fere graduum, attenta videlicet parte Lunæ Boreali.

Præterea etiam maxime notatu dignum, quod ex hac observatione Diametrum Jovis exquisite elicere potuerim, & quidem hac ratione: cognita nimirum tota duratione Occultationis 42^m. 6^s. atq; data simul Diametro Lunari 31^m. protinus innotescit, ex illa temporis mora, cum scilicet Jupiter limbo suo primum Lunæ limbum attingeret, & cum totus occultaretur (id quod factum est spatio temporis 1^m. 30^s.) Diameter Jovis 51^m. 42^s.

Et tantæ Magnitudinis extitit etiam Diameter Jovis 50 circiter secund. quoties illam per maculas Lunæ dimensus sum: uti ex parte secunda Machinæ nostræ cœlestis suo loco patet. Quod autem Anno 1679. die 5 Jun. cum similem Jovis Eclipsim observarem, longe ea extiterit minor, nimirum tantum 30^m. 53^s. Id ex eo evenisse puto, quod Observatio illa, tempore diurno, splendente Sole fuerit observata; quo radii Stellarum & Planetarum adventitii magis a Luce Solis absterguntur, quam tempore nocturno, nocte obscura. Quod si autem quæras, quamnam Diametrum apparentem veriore existimem? scias illam, quam Anno 1679, 5 Jun. de die, sole splendente observavi. Non quidem ex eo quod non æque diligenter hanc quam illam determinaverim; sed quod tempore nocturno, radii adven- titii

titii magis obſtent, ſicuti diximus, quam tempore diurno. An vero recte Judicium meum expono, futura Obſervationes, dummodo accuratiſſime peragentur, docebunt.

Poſtremo Corollarii loco, adhuc adjiciam Tabellam, calculum hujus occultationis Jovis, ex diverſorum Auctorum, videlicet Keppleri, Lansbergii, Bullialdi, Riccioli & Wingii Tabulis exhibentem; ut ſub uno ſtatim intuitu quilibet habeat in quantum ab ipſa Obſervatione & ipſo cœlo dictæ Tabulæ diſcedunt. Invenies non tantum in plurimis integris Minutis, ſed ad ſemihoram, imo integram nonnullas a vero exorbitare; ſic ut Rerum Cœleſtium Cultores abunde adhuc habeant, quod quærant, caſtigant.

Calculus ad Horizontem Gedanenſem.

Gedani.	Ex Obſerv.	Ex Keple.	Ex Lanſb.	Ex Bulli.	Ex Riccio.	Ex Wingio
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.
<i>Incipit.</i>	11 7 9	10 31 5	12 15 25	10 38 21	10 47 9	10 18 4
<i>Terminat.</i>	11 8 29	10 33 17	12 18 45	10 40 41	10 49 41	10 18 8
<i>Emiſſio.</i>	11 42 13	11 17 45	13 1 26	11 21 43	11 47 13	11 23 20
<i>Termin.</i>	11 50 45	11 19 57	13 4 47	11 24 03	11 49 45	11 23 24
<i>Duratio.</i>	0 42 6	0 48 52	0 49 22	0 45 42	1 2 36	1 5 20
<i>Semid.</i>	0 15 30	0 16 12	0 17 52	0 16 52	0 16 13	0 16 32

Quibus finio, & Te, Benigne Aſtrophile, bene valere jubeo, rogans, ut qualem qualem hancce Obſervatiunculam boni conſulas, donec quædam præſtantiora in Lucem prodeant. &c.

PRiuſquam hæſce literas obſignarem, in manus meas inciderunt paucula illa, quæ de conjunctione Lunæ & Jovis poſteriori, die 8 Maj. *ſt. N.* mane, a me fuerunt annotata. Idcirco & ea volui, licet nullius ſint ponderis, vobis communicare.

Pri-

Primo, observata est Altitudo Arcturi, pro corrigendo tempore; deinde quasdam Distantias determinavi, ea intentione, me forte adhuc posse, ante ipsum occasum horum siderum, minimum, initium Occultationis deprehendere; sed spe frustratus sum. Nam citius circa Horizontem & Lunam & Jovem Nubeculae exceperunt, atq; paulo post obitus horum Planetarum omnino incidit.

<i>Secun. Horolog ambul.</i>	Occultatio Jovis quæ accidere debuit Dantisci Anno 1686. die 8 Maji. St. N. mane.	<i>Tempus Correct.</i>
H. M. S.	<i>gr. m. s.</i>	H. M. S.
3 23 20	Altitudo Arcturi. 31 16 0	3 20 12
3 24 25	Eadem Altitudo. 31 4 0	3 21 35
3 44 30	Jupiter a limbo > distabat majori adhuc intervallo quam M. Sinai a M. Ætna.	3 41 30
3 47 0	Jovis distantia erat tanta, quanta M. Porphyritidis a Byzantio.	3 44 0
3 52 0	Jovis a limbo Lunæ distantia erat æqualis distantiae Insulæ Sardiniae & Paludis Maræotidis.	3 49 0
3 59 0	Jupiter a limbo Lunæ paulo plus distabat quam Pal. Maræotis ab Ætna.	3 56 0
4 16 40	Distantia Jovis a limbo Lunæ æquabatur fere Distantiæ M. Porphyritidis ab Insula Cercinna. Planetarum Occasus factus est.	4 13 40 4 17 0

Adeo ut nihil quicquam de ipsa Occultatione nobis hic, Gedanum in conspectum venerit; quibus valete iterum iterumq; quam felicissime.

JOHANNES HEVELIUS.

An account of a Book. *Methodus Figurarum lineis rectis & curvis comprehensarum quadraturas determinandi* Authore J. Craige. 4to. Londini 1685.

THE great use of drawing the Tangents of Curve Lines, has made the most famous amongst the Modern Mathematicians endeavour to find out General Methods of finding the Tangents of Curve Lines, as may be seen from the several ways invented by *Des Cartes*, *Monsieur Fermat*, *Slusius*, *Dr. Barrow*, *Dr. Wallis*, *Tschurnehuus*, and *Leibnitius*; But as yet none has attempted to invert this problem generally, that is, having the Tangent to find the Curve Line whose tangent it is. Therefore the Author of this Treatise perceiving that the doing of this would give a General Method of determinating the Quadrature of any Curvilinear space, has laid down a rule for inverting *Slusius* his method mentioned in the *Philosophick Transactions* Num. 90. He has illustrated his Method of Quadratures by several Figures which have been already considered by Geometers. As for the Circle & Hyperbola, he asserts that their indefinite Quadratures are impossible, and therefore in these & such like cases, he expresses the Area by an infinite Series, which is easily done by his Method, except the Series consist of irrational termes, for in these he has recourse to *Leibnitius* his method of finding Tangents, where the Calculation will be more tedious. By his resolving the Area of the Hyperbola into an infinite series, he comes to the same expression with that of *N. Mercator*: And in measuring the Zone of a Circle, his expression falls in with that invented by *Mr. Isaac Newton*, as *Mr. David Gregory* relates in his Treatise. He has subjoyned a Method of measuring the Curve Superficies made by the rotation of any Curve upon its Axis; with a small Animadversion on the Method of *Quadratrices*, published in the *Acta Lipsiensia Eruditorum* of October, 1681.

Since the Publication of this Treatise, the Author is pleased to make the following Addition.

Z

Addi-

Additio ad Methodum Figurarum Quadraturas Determinandi. Autore Johanne Craige.

Quoniam omnium Figurarum Quadraturæ ex perfecta nostri primi problematis Solutione determinantur; propterea utile judicabam nonnulla addere, quæ solutionem meam non modo plenius illustrant sed omnino perficiunt: non adeo tamen sunt obscura, quin facile quisquam in istiusmodi rebus versatus, ex iis quæ jam exposui, omnia supplere possit. Problema sic se habet. Data expressione Analytica lineæ inter ordinatam & Curvæ perpendiculararem designatæ, Invenire æquationem naturam illius Curvæ definientem. Hoc problema tres casus includit. 1. Cum expressio istius lineæ talis est, qualis a vulgaribus tangentium Methodis exhibetur. 2. Cum ad simpliciores reducitur, facta divisione numeratoris & denominatoris per communem simplicem divisorem. 3. Cum expressio sit simplicissima, dividendo per divisorem compositum. Duos priores casus Regula, prout eam explicui, universaliter comprehendit; superest tantum ut ostendam quo pacto tertium pariter casum comprehendat.

Postquam expressio data per y multiplicatur, apponantur omnes termini qui sub maximo continentur (Terminorum magnitudinem e dimensionibus quantitatis y mensurans) & connectantur signo affirmativo vel negativo, prout libuerit; adequentur omnes illi termini (prius in coefficientes incognitas multiplicati) Quadrato quantitatis per x designatæ: eritq; inde resultans æquatio quæsitæ, vel quæsitam includet; & determinationes coefficientium terminos æquationem constituentes a reliquis distinguunt.

Sit in appposito schemate abscissa $AM=y$, ordinata $MC=z$,

& Curva ACE proprietat $z^2 = \frac{a^2 y^2 + y^4}{p^2}$, & invenienda sit

quadratura Area a lineis rectis & illa Curva comprehensa. Quarenda est alia Curva A G H, in qua $PM =$

$$\sqrt{\frac{a^2 y^2 + y^4}{p^2}} = z; \text{ ubi } PG \text{ Curva}$$

quaesita perpendicularem, & $MG=x$ illius ordinatam denotat. Cumq; hac expressio linea PM in y multiplicata contineat sextam quantitatis y dimensionem, ideo appono omnes terminos sub

illa sexta dimensione contentos, unde resultans aequatio est.

$$\frac{na^6 + ma^5 y + la^4 y^2 + ha^3 y^3 + ka^2 y^4 + gay^5 + fy^6}{p^2} = x^4.$$

Ex hac aequatione invenio valorem Lineae PM. quem comparo cum valore dato, unde

$$PM = \frac{ma^5 + 2la^4 y + 3ha^3 y^2 + 4ka^2 y^3 + 5gay^4 + 6fy^5}{4p\sqrt{na^6 + ma^5 y + la^4 y^2 + ha^3 y^3 + ka^2 y^4 + gay^5 + fy^6}}$$

$$= \sqrt{\frac{a^2 y^2 + y^4}{pp}} \text{ auferantur fractiones \& Signa radicalia, \& deter-}$$

minentur coefficientes n, m, l &c: (ut in prob: 2 tractatus nostri) rejectis itis quarum determinationes absurdum involvunt: & cetera, in quibus nihil tale contingit, aequationem constituent. Sic

in exemplo proposito, erit $f = \frac{4}{9}$, $k = \frac{1^2}{9}$, $l = \frac{1^2}{9}$, $n = \frac{4}{9}$. sed dum g

determino, invenio $240g = 144g$, quod absurdum involvit; & sic pro h comparatio erit $16h = 16h$ unde nullus illius valor, & pro m erit $48m = 144m$, quod itidem est absurdum: quapropter termini a quantitibus g, h, m affecti ad aequationem non pertinebunt; unde reliqui a literis n, l, k, f affecti aequationem naturam

Curva definientem constituent. sc. $\frac{4a^6 + 12a^4 y^2 + 12a^2 y^4 + 4y^6}{9p^2}$

$$= x^4,$$

$$=x^4, \text{ adeoq; } AMC = \sqrt{\frac{a^6 + 3a^4y^2 + 3a^2y^4 + y^6}{6p^2}} = \frac{x^2}{2}. \text{ Exem. 2}$$

Sit Curva Linea ACE talis proprietates $z^2 = \frac{qy^2 + y^3}{p}$ & inveni-
nienda sit Quadratura spatii AMC. Querenda est Curva AGH
in qua sit $PM = \sqrt{\frac{qy^2 + y^3}{p}} = z$ & quoniam hic valor in y mul-
tiplicatus continet quintam quantitatis y dimensionem, apponantur
omnes termini sub illa quinta dimensione, & aequentur quadrato
quantitatis per x designatae; unde aequatio resultans est.

$$\frac{nq^5 + mq^4y + lq^3y^2 + kq^2y^3 + hqy^4 + fy^5}{p} = x^4. \text{ atq; sola coeffi-}$$

cientis (m) determinatio absurdum involvet, eruntq; reliquae,
 $n = \frac{64}{225}, l = -\frac{16}{15}, k = -\frac{16}{45}, h = \frac{16}{15}, f = \frac{16}{25}$, unde aequatio curvam
quaesitam definiens est.

$$\frac{64q^5}{225p} - \frac{16q^3y^2}{15p} - \frac{16q^2y^3}{45p} + \frac{16qy^4}{15p} + \frac{16y^5}{25p} = x^4 \text{ adeoq;}$$

$$AMC = \sqrt{\frac{16q^5}{225p} - \frac{4q^3y^2}{15p} - \frac{4q^2y^3}{45p} + \frac{4qy^4}{15p} + \frac{4y^5}{25p}} = \frac{xx}{2}$$

Exem. 3. Invenienda sit Quadratura spatii AMC, definita
Curva ACE hac Aequatione $z^2 = \frac{3a}{4y + 4a}$. Queratur

alia Curva AGH, in qua $PM = \sqrt{\frac{a^3}{4y + 4a}} = z$. Ex praemissis

constat Aequationem primam fore $\frac{na^3y^2 + ma^4y + 16a^5}{4a + 4y} = 4x^4$

& determinationes Coefficientium $n = 16, m = 32, l = 16$.

Quibus substitutis; erit aequatio $\frac{16a^3y^2 + 32a^4y + 16a^5}{4y + 4a} = x^4$

$$= 4a^3y + 4a^4: \text{ adeoq; } AMC = \sqrt{a^3y + a^4} = \frac{1}{2}x^2.$$

Notatu dignissimum est, has tres (sicut infinitas alias) Qua-
draturas abscissae AM (seu y) non convenire. Quoniam in istius-
modi

modi Figuris, simplicissima Area expressio huic portioni non respondet: attamen Quadratura abscissæ conveniens exinde parvo labore deducitur. Ut in Exem: 3. ubi Area est $\sqrt{a^3y + a^4}$; fiat $y = 0$, & erit Area $\sqrt{a^4} = a^2$, & subducatur hac ex generali, proveniet Quadratura portionis abscissæ respondentis, sc. $\sqrt{a^3y + a^4} - a^2$. Quam observatiunculam mihi primus significavit Vir celeberrimus D. Isaacus Newton.

Tentetur jam idem processus in Circulo ACE, cujus diameter sit r , ac proinde $Z = \sqrt{ry - y^2}$, Quærenda est Curva AGH in qua $PM = \sqrt{ry - y^2} = Z$, sed ex dictis constat æquationem primam fore $nr^4 + mr^3y + lr^2y^2 + hry^3 - ky^4 = x^4$: & singulæ coefficientium determinationes erunt impossibiles; adeoque nulla datur Curva AGH in qua $PM = \sqrt{ry - y^2}$, ac proinde Circuli Quadratura indefinita est impossibilis. Fieri tamen potest ut sit aliqua hujusmodi Curva AGH, sed ex earum numero, quas post Cartesium Mechanicas Geometræ communiter appellant: sed quia harum usus non libenter admittunt Mathematici, præstat hujusmodi Quadraturas per series infinitas exhibere.

Benevole Lector

Ob inopiam Typorum Numeralium minusculorum, qui ad designandas quantitatum potestates supra Symbola dextrorsum apponi solent, festinante prælo, Typographus paulo majoribus usus est in eadem linea immediate sequentibus; ubicunq; itaq; offenderis a^3 , vel x^2 , &c. cubum vel quadratum, &c. e quantitate, cui suffigitur numerus, intelligas.

L O N D O N,
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PHILOSOPHICAL

TRANSACTIONS.

For the Month of *October*, 1686.

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An Account of the Course of the Tides in the Port of Dublin in Ireland, communicated in a Letter to the Publisher, from William Molineux Esq. R. S. S. with a remark thereupon.

AT the Barr of *Dublin*, on the New and Full Moons, a South-South-East Moon makes high Water, that is, at half an hour after Ten.

At *Rings-End* at Three Quarters after Ten.

At the Custome-House at *Dublin* at Eleaven.

On the Quarter Days.

High Water on the Barr at five of the Clock.

At *Rings-End* at a Quarter past Five.

At the Custom House half an hour past Five.

A Southerly Wind between S. S. E. and S. S. W. blowing fresh makes it flow near half an hour longer than it's usual Course.

N. B. that this observation makes the Tides, upon the Quarter Moons, come in later, in respect of the Moons Southing, than upon new and full Moons, by half an hour : whereas in the River of *Thames*, as high as *London*, the Quarter Moons make high Water above an hour an Quarter sooner, in that respect, than the New and Full ; as may be seen by the accurate Tide Tables of Mr. *Flamsteed* : but it is from hence Evident that the same Tables are not applicable to the Sea-Ports ; where there is not the same reason for the Anticipation of the Nepe Tides upon the Quarter Moons. The cause of this *Plancmenon* seems to be, that the Impulse of the Ocean in the Quarter Moons is not so Vigorous as in the New and Full ; nor the Motion of the Waters so quick : (as is evident by dayly experience) whence it comes to pass that in the open Sea, and in Ports upon the Sea-Coast, as this of *Dublin*, the high Water time falls out later, than when the motion is more rapid in the New and Full ; but on the

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contrary, in Rivers, at any considerable distance from the Sea, the resistance of the weight of the fresh Water, which is kept suspended during the time of the Flood, is longer overcome by the more potent *Impetus* in the New and Full, than by the weaker in the *Quadratures*: and from hence this difference should be still more and more considerable as the Port is farther removed from the Sea.

A Demonstration of the Velocity wherewith the Air rushes into an Exhausted Receiver, lately produced before the R. Society by Dr. D. Papin. Reg. Soc. S.

There being several Occasions wherein it would be useful to know the Velocity of the Air, according to the several pressures that may drive it; The Royal Academy at *Paris* hath attempted by some Tryals to attain that Knowledge, and by means of a Bladder, which they did sometimes fill up with Water, and sometimes with Air; they found that (although the Weight to squeeze out these Liquors, and the hole to let them out were the same) nevertheless, the Bladder when full of Air, could be empty'd in the 25th. part of the time that was required to squeeze out the Water of the same Bladder: from thence they concluded that the swiftness of the Air is 25 times greater than that of water, when both these liquors bare the same pressure. This Experiment was very well thought on, and might serve till a better should be found out; but those Gentlemen could not but know, that this was not Perfect: The Reason is that the Air yieldeth much, and so the Bladder being fill'd with it, will become pretty flatt, as soon as a considerable weight is layd upon it. It is plain therefore that the weight bearing upon a large space doth not press every part with the same force as it would do, if the Bladder did for a while remain Plump, as it doth when full of water: moreouer, the water it self being heavy in the Bladder, makes some pressure: so

that it appears, that the pressure in this experiment was not quite so great vpon the Air as vpon the water: I haue therefore thought of another way, which I think better, to come to the said Knowledge; and I do humbly submit it to the *R. Society*.

My way is grounded vpon this *Hydrostatical Principle*, that liquors haue a strength to ascend as high as their source is; and although the resistance of the *Medium* doth always hinder *Iets d'eau* in the open Air from reaching quite so high, neuertheless the liquor at its first spouting out, hath the necessary swiftness to come to that height.

Proposition. I.

From this Principle may easily be deduced this Proposition, that of two differing liquor's driven by the same pressure, that which is *in specie* lighter must ascend higher than that which is heavier, and their heights will be reciprocally in the same reason as their specifick gravity's are. Thus, Quicksiluer being 13 times and a half heavier than water, bears as much pressure when its spring is one foot above the spout hole, as water doth when it's spring is 13 foot and a half high, and the height to which Mercury shall ascend will be 13 times and a half lesser than the height to which water shall be driven by those equall pressures.

Proposition. II.

From the foregoing Proposition another may easily be deduced, *viz*, That of differing liquors bareing the same pressure those that are lighter *in specie* must acquire a greater swiftness, and their differing Velocity's are to one another as the roots of the specifick Gravity's of the sayd liquor's

For we haue seen *Prop. 1.* that the height's to be attain'd are in the same reason as the specifick gravity's; Now *Galileus*, *Hugenius*, and others haue demonstrated that the Velocities

city's of bodies are to one another as the square roots of the heights to which they may ascend: and so in this occasion they are also as the roots of the specifick Gravity's.

If therefore we would know what is the Velocity of Air being driven by any degree of pressure whatsoever, we ought but to find what would be the velocity of water vnder the same pressure: and then take the square roots of the specifick grauitys of these two liquor's; because as much as the square root of the specifick Gravity of Water, doth exceed the square Root of the specifick Gravity of Air; so much in Proportion will the velocity of Air exceed the velocity of water. For example, when I would compute what should be the swiftness of a bullet shott by the Pneumatick Engine, as hath been described in *Philosophical Transaction*, Num. 179. I should first compute what was the velocity of the Air it self that droue the Bullet: I did therefore take notice that in this occasion the Air bares a pressure much about the same as that of water when it's spring is 32 foot high: now such water would spout out with a sufficient velocity to ascend 32 foot perpendicular, and therefore, according to the rules and obseruation of *Galileus*, *Halley* and others, such water hath the velocity of 45 foot in a second. It remains therefore but to know the proportion of the grauity of Air to that of Water: and we haue found it not to be always the same; because the heighth, the heat, and the moisture of the Atmosphere are variable: neuertheless we may say in general that the reason between the specifick grauitys of water and Air is much about 840 to 1. Taking then their square roots, as I haue sayd aboue, which roots are 29 and 1, we may conclude that the velocity of Air must exceed that of water by 29 times: and so multiplying 45, the velocity of water, by 29, we shall find that the velocity of the Air driven by the whole pressure of the Atmosphere, is about 1305 foot in a second.

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An Extract of a Letter from Mr. J. Flamsteed Astr. Reg. and Reg. Soc. S. giving his calculation of the Eclipses of Jupiters Satellites for the Year 1687. Together with a Table of the Parallaxes of the Orb, and an Ephemeris of Jupiters Geocentric Place for the same Year; to which is added an Observation of the Eclipse of the Moon, Novemb. 30, 1685. made at Lisbon, and Mr. Flamsted's own Observation of the Eclipse of Jupiter by the Moon on March 31th. past.

I Give you here a Catalogue of all the Eclipses of γ s Satellites, for the ensueing year 1687. and together with it 2 Tables, one of his Geocentrick places, the other of the Parallaxes of his Orbit to every day in the said Year. This is the 4th. Catalogue I have got published in the Transactions. With the 1st. printed Dec. 1683. Num. 154. I shewed their uses, and how by their help the difference of Longitude, betwixt any two places on the Earth, where they should be observed, might be determined. And I Taught a Method of finding out within what space on our Globe any of them would be observable: This was done in English for the use of our Country-men. Next Year in December 1684. I repeated those Directions in Latin Num. 165. pag. 760. for the benefit of Forreigners. In the two Transactions of Decem. 85. Num. 177 and 178, with the Catalogue of Eclipses I described a small Instrument, and shewed by the help of it, the said Catalogue, and the Tables of γ Geocentrick places and Parallaxes, the appearances of the Satellits at any time within the compass of that Year might be discovered and delineated; if therefore the Reader desire to be informed concerning the use of the Catalogue and Tables herewith printed

ed, he may repair to the above-mentioned Transactions. I shall only add.

That whereas for the two Years last past, the 4th. Satellit has not been Eclipsed. As this Year enters, it begins to fall into γ 's shadow, and that its Eclipses will again be observable for the 4 next Yeares. The first that happens *Feb.* 2. in the Morning will be well worth the attention of the Curious; in that its duration is the shortest of any that follow it this Year; both the Ingresse and Emerfion are Visible with us, as are all those in the Catalogue which are alike marked with an Asterisck (*) which if they shall be exactly obserued, may serue to determine the place of the Node of the orbit of γ 's Satellits, and its Inclination to the orbit of γ , by compareing the obseruation either with such as wee haue already obtained, or as may be made hereafter.

In my last obseruations, the Eclipses of the 2^d and 3^d Satellit have anticipated my Calculations something more than I expected in so short a time; of which I thought it conuenient to acquaint the Reader, that hee may attend them one quarter of an hour earlyer than the times noted in the Catalogue. In 2 or 3 years more wee may expect opportunitys of obseruations, which will afford us such a correction for the error, that the Numbers shall fail no more in them, than in the 1st. whose Eclipses haue not yet differed aboue 3 minutes from the Calculation.

I giue you further herewith an obseruation of the Lunar Eclipse *November* 30, 1685. made at *Lisbon* by my kind Friend Mr. *Henry Jacobs*: and another of my own of the Occultation of γ by the Moon, *March* the 3th. this Year 1686: of which you haue published seuerall forreign obseruations already.

Tab.

Tabula Parallaxium Jovis

Janua.		Februa.		Martii.		April.		Maii.		Junii.		
D	A	A		A		A		A		S		D
	G. M.	G.	M.	G.	M.	G.	M.	G.	M.	G.	M.	
1	30	9	36	10	49	9	41	5	48	0	16	1
2	38	9	41	10	49	9	36	5	38	0	29	2
3	44	9	45	10	50	9	31	5	27	0	41	3
4	52	9	49	10	50	9	25	5	17	0	54	4
5	59	9	53	10	50	9	19	5	0	1	06	5
6	06	9	57	10	49	9	13	4	55	1	19	6
7	13	10	01	10	49	9	07	4	44	1	31	7
8	20	10	04	10	48	9	01	4	33	1	44	8
9	26	10	08	10	48	8	55	4	22	1	56	9
10	33	10	11	10	47	8	48	4	11	2	08	10
11	40	10	14	10	46	8	41	3	59	2	21	11
12	46	10	18	10	44	8	34	3	48	2	33	12
13	53	10	21	10	42	8	27	3	36	2	45	13
14	59	10	24	10	41	8	19	3	24	2	57	14
15	06	10	26	10	40	8	12	3	12	3	09	15
16	11	10	29	10	38	8	04	3	00	3	21	16
17	17	10	31	10	36	7	56	2	48	3	33	17
18	23	10	34	10	33	7	48	2	37	3	44	18
19	29	10	36	10	31	7	40	2	25	3	56	19
20	35	10	38	10	28	7	32	2	12	4	08	20
21	41	10	40	10	25	7	23	2	00	4	19	21
22	46	10	41	10	22	7	14	1	48	4	30	22
23	52	10	43	10	19	7	05	1	35	4	42	23
24	57	10	44	10	15	6	56	1	23	4	53	24
25	02	10	45	10	12	6	47	1	11	5	04	25
26	08	10	46	10	08	6	37	0	58	5	15	26
27	13	10	47	10	04	6	28	0	45	5	25	27
28	17	10	48	10	00	6	18	0	33	5	36	28
29	22			9	55	6	08	0	21	5	46	29
30	27			9	51	5	58	0	A 08	5	57	30
31	31			9	46			0	S 04			31

ad diem quemlibet Anni 1687.

	Julii.		Augu.		Sept.		Octob.		Novem.		Decem.		
D	S		S		S		S		S		S		D
	G.	M.G.	G.	M.G.	G.	M.G.	G.	M.G.	G.	M.G.	G.	M.	
1	6	07	10	02	11	02	9	37	6	24	2	10	1
2	6	17	10	06	11	02	9	32	6	17	2	09	2
3	6	27	10	11	11	01	9	28	6	09	2	00	3
4	6	37	10	15	11	00	9	23	6	02	1	52	4
5	6	47	10	19	10	59	9	18	5	54	1	42	5
6	6	56	10	23	10	57	9	12	5	46	1	34	6
7	7	05	10	27	10	56	9	07	5	38	1	25	7
8	7	14	10	31	10	54	9	01	5	31	1	16	8
9	7	23	10	34	10	52	8	56	5	23	1	07	9
10	7	32	10	37	10	50	8	50	5	15	0	58	10
11	7	41	10	40	10	48	8	45	5	07	0	50	11
12	7	49	10	43	10	46	8	39	4	59	0	41	12
13	7	57	10	46	10	43	8	33	4	51	0	32	13
14	8	05	10	48	10	41	8	27	4	42	0	23	14
15	8	14	10	50	10	38	8	21	4	34	0	14	15
16	8	21	10	52	10	35	8	15	4	26	0	05	16
17	8	29	10	54	10	32	8	08	4	18	0	04	17
18	8	36	10	56	10	29	8	02	4	09	0	13	18
19	8	44	10	57	10	26	7	55	4	01	0	22	19
20	8	51	10	59	10	23	7	49	3	53	0	31	20
21	8	58	11	00	10	19	7	42	3	44	0	40	21
22	9	05	11	01	10	15	7	36	3	36	0	48	22
23	9	11	11	02	10	11	7	29	3	27	0	57	23
24	9	28	11	03	10	08	7	22	3	19	1	06	24
25	9	24	11	03	10	04	7	15	3	10	1	15	25
26	9	30	11	04	10	00	7	08	3	01	1	24	26
27	9	35	11	04	9	56	7	01	2	53	1	33	27
28	9	41	11	04	9	51	6	54	2	44	1	42	28
29	9	46	11	04	9	47	6	46	2	35	1	5	29
30	9	52	11	04	9	42	6	39	2	27	1	59	30
31	9	57	11	03		6	32			2	08		31

Catalogus Eclipsium Comitum Jovialium ubique Terrarum Anno ii

Januarii.						Februarii.						Martii.					
D.	H.	M.				D.	H.	M.				D.	H.	M.			
1	01	27	1	i		1	02	1	3	e		1	15	04	*	i	
2	09	34	2	i			17	2	*	i			18	06	3	*	e
	19	55	1	*	i		18	2	4	*	e	2	05	27	1	i	
3	07	23	3	i			21	5	1	i		3	19	25	2	i	
4	14	22	1	i		3	09	04	2	i			23	56	1	i	
5	22	50	2	i			16	19	1	*	i	5	18	26	1	*	i
6	08	50	1	i		5	10	47	1	i		7	05	05	4	i	
8	03	17	1	i		6	22	21	2	i			6	43		e	
9	12	06	2	i		7	05	16	1	i			8	44	2	i	
	21	45	1	i		8	03	08		i			12	54	1	i	
10	11	18	3	i			6	08	3	e		8	19	03		i	
11	16	13	1	i			23	44	1	i			22	06	3	e	
13	01	23	2	i		10	11	39	2	i		9	07	22	1	i	
	10	41	1	i			18	13	1	*	i	10	22	02	2	i	
15	05	09	1	i		12	12	41	1	i		11	01	52	1	i	
	23	53	4	pen		14	00	56	2	i		12	20	20	1	i	
16	14	39	2	i			7	10	1	i		14	11	40	2	i	
	23	37	1	i		15	7	06		i			14	49	1	*	i
17	15	15	3	i			10	07	3	e		15	23	03		i	
	18	14	3	*	e	16	01	38	1	i		16	02	06	3	e	
18	18	05	1	*	i	17	14	14	2	i			9	18	1	i	
20	03	56	2	i			20	07	1	i		18	00	39	2	i	
22	07	01	1	i		18	11	11		i			3	47	1	i	
23	17	12	2	*	i		12	32	4	e		19	22	16	1	i	
24	01	29	1	i		19	14	35	1	i		21	13	57	2	*	i
	19	12		*	i	21	03	32	2	i			16	44	1	*	i
	22	11	3	e			9	04	1	i		23	03	03	3	i	
25	19	57	1	i		22	11	05		i			6	07		e	
27	06	29	2	i			14	06	3	e			11	13	1	i	
	14	25	1	i		23	03	33	1	i			23	02		i	
29	08	54	1	i		24	16	50	2	*	i	24	0	54	4	e	
30	19	47	2	i			22	01	1	i		25	3	15	2	i	
31	03	22	1	i		26	16	50	1	*	i		5	42	1	i	
	23	10	3	i		28	06	07	2	i		27	00	11	1	i	
							10	59	1	i		28	16	34	2	*	i
													18	39	1	i	
												30	07	02		i	
													10	08	3	e	
													13	09	1	*	i

Julii.					Augusti.					Septemb.				
D.	H.	M.			D.	H.	M.			D.	H.	M.		
1	13	53	3	e	1	12	42	1	e	1	04	33	2	e
2	10	32	1	e	3	07	11	1	e	2	09	29	1*	e
	10	38	4*	i		17	58	2	e	3	22	48	3	i
	13	32	4	e	4	22	40	4	i	4	02	07	3	e
	18	13	2	e	5	1	40	1	e		3	59	1	e
4	05	00	1	e		1	52	4	e		17	53	2	e
5	23	29	1	e	6	06	40	3	i	5	22	28	1	e
6	07	32	2	e		9	56	3*	e	7	10	55	†	i
7	17	57	1	e		20	09	1	e		14	21	4	e
8	17	52	3	e	7	07	17	2	e		16	58	1	e
9	12	26	1*	e	8	14	38	1	e	8	07	13	2*	e
	20	59	2	e	10	09	07	1*	e	9	11	27	1	e
11	06	55	1	e		20	37	2	e	11	02	51	3	i
13	01	23	1	e	12	03	37	1	e		5	57	1	e
	10	07	2*	e	13	10	42	3	i		6	10	3*	e
14	19	52	1	e		13	58	3	e		20	32	2	e
15	18	38	3	i		22	06	1	e	13	00	26	1	e
	21	52	3	e	14	09	56	2*	e	14	18	56	1	e
16	14	21	1	e	15	16	35	1	e	15	09	52	2	e
	23	25	2	e	17	11	05	1	e	16	13	25	1	e
18	08	50	1	e		23	15	2	e	18	06	54	3*	i
19	04	38	4	i	19	05	34	1	e		7	54	1*	e
	7	40	4	e	20	14	44	3	i		10	13	3	e
20	03	19	1	e		18	01	3	e		23	12	2	e
	12	43	2	e	21	00	03	1	e	20	02	24	1	e
21	21	47	1	e		12	35	2	e	21	20	54	1	e
22	22	38	3	i		16	47	4	i	22	12	31	2	e
23	01	53	3	e		20	05	4	e	23	15	23	1	e
	16	16	1	e	22	18	33	1	e	24	05	03	4	i
24	02	02	2	e	24	13	02	1	e		8	37	4	e
25	10	45	1*	e	25	01	54	2	e	25	09	52	1	e
27	05	14	1	e	26	07	32	1*	e		10	56	3	i
	15	21	2	e	27	18	46	3	i		14	16	3	e
28	23	43	1	e		22	03	3	e	26	01	51	2	e
30	02	39	3	i	28	02	01	1	e	27	04	20	1	e
	05	54	3	e		15	14	2	e	28	22	51	1	e
	18	12	1	e	29	20	31	1	e	29	15	10	2	e
31	04	39	2	e	31	15	00	1	e	30	17	20	1	e

Octobris.				Novembr.				Decembre.			
D.	H.	M.		D.	H.	M.		D.	H.	M.	
2	11	49	1 e	1	14	01	1 e				
	14	58	3 li	3	08	26	1 e				
	18	18	3 e	4	04	15	2* e				
3	04	29	2 e	5	02	58	1 e				
4	06	19	1* e	6	21	26	1 e				
6	00	48	1 e	7	14	21	3 e				
	17	48	2 e		17	32	2 e				
7	19	17	1 e	8	15	54	1 e				
9	13	46	1 e	10	10	23	1 e				
	18	59	3 i	11	06	50	2 e				
	22	20	3 e	12	04	51	1 e				
10	07	07	2* e	13	11	15	4 li				
	23	11	4 i		15	04	4 le				
11	02	49	4 e		23	19	1 e				
	8	15	1 e	14	20	07	2 e				
13	02	44	1 e		18	20	3 e				
	20	26	2 e	15	17	47	1 e				
14	21	13	1 e	17	12	15	1 e				
16	15	42	1 e	18	09	24	2 e				
	23	00	3 i	19	06	43	1 e				
17	02	22	3 e	21	01	12	1 e				
	9	45	2 e		22	17	3 e				
18	10	11	1 e		22	40	2 e				
20	04	40	1* e	22	19	39	1 e				
	23	03	2 e	24	14	07	1 e				
21	23	09	1 e	25	11	57	2 e				
23	17	37	1 e	26	08	35	1 e				
24	06	23	3 e	28	03	03	1 e				
	12	21	2 e	29	01	13	2 e				
25	12	06	1 e		2	14	3 e				
27	06	35	1 e		21	30	1 e				
	17	13	4 i	30	05	04	4 i				
	20	59	4 le		9	00	4 le				
28	01	39	2 e								
29	01	03	1 e								
30	19	32	1 e								
31	10	22	3 e								
	14	57	2 e								

*Toto Decembre
Jupiter latet
sub Radiis
Solis.*

Jovis loca Geocentrica

	Janu.		Febru.		March.		April.		May.		June.		
	†		†		†		†		†		†		
	G.	M.	G.	M.	G.	M.	G.	M.	G.	M.	G.	M.	
1	13	46	19	19	22	46	24	07	2	39	19	05	1
2	13	58	19	29	22	51	24	07	22	34	18	57	2
3	14	10	19	38	22	57	24	07	22	28	18	49	3
4	14	22	19	47	23	02	24	06	22	22	18	42	4
5	14	34	19	55	23	06	24	05	22	16	18	34	5
6	14	45	20	04	23	11	24	04	22	10	S	27	6
7	14	57	20	12	23	15	24	03	22	04	18	19	7
8	15	09	20	21	23	20	24	01	21	58	18	11	8
9	15	20	20	29	23	24	23	59	21	52	18	04	9
10	15	32	20	38	23	27	23	58	21	45	17	50	10
11	15	43	20	46	23	31	23	56	21	39	17	48	11
12	15	54	20	54	23	35	23	54	21	32	17	41	12
13	16	06	21	01	23	38	23	51	21	25	17	34	13
14	16	16	21	09	23	41	23	49	21	18	17	27	14
15	16	27	21	17	23	44	23	46	21	11	17	20	15
16	16	38	21	24	23	47	23	43	21	04	17	13	16
17	16	49	21	31	23	50	23	40	20	57	17	06	17
18	17	00	21	38	23	52	23	37	20	50	16	59	18
19	17	10	21	45	23	55	23	33	20	43	16	52	19
20	17	21	21	52	23	57	23	30	20	35	16	46	20
21	17	32	21	59	23	59	23	26	20	28	16	39	21
22	17	42	22	05	24	00	23	22	20	20	16	33	22
23	17	52	22	12	24	02	23	18	20	14	16	26	23
24	18	02	22	18	24	03	23	14	20	06	16	20	24
25	18	12	22	24	24	04	23	09	19	58	16	14	25
26	18	23	22	30	24	05	23	04	19	50	16	08	26
27	18	33	22	35	24	06	23	00	19	43	16	02	27
28	18	42	22	41	24	07	22	56	19	35	15	56	28
29	18	51			24	07	22	50	19	28	15	51	29
30	19	0			24	08	22	43	19	20	15	44	30
31	19	10			24	08		19	12				31

in diem quemlibet Anni. 1687.

	Julii.		August.		Septem.		Octob.		Novem.		Dece.		
D	†		†		†		†		†		v		D
	G.	M.	G.	M.	G.	M.	G.	M.	G.	M.	G.	M.	
1	15	40	14	D 17	15	47	19	40	25	27	2	02	1
2	15	34	14	17	15	53	19	50	25	39	2	16	2
3	15	29	14	17	15	59	19	59	25	51	2	29	3
4	15	24	14	17	16	05	20	10	26	04	2	43	4
5	15	20	14	18	16	11	20	20	26	17	2	57	5
6	15	15	14	19	16	17	20	30	26	29	3	11	6
7	15	11	14	21	16	24	20	40	26	42	3	25	7
8	15	07	14	22	16	30	20	51	26	55	3	38	8
9	15	03	14	23	16	37	21	01	27	08	3	52	9
10	14	59	14	25	16	44	21	12	27	21	4	06	10
11	14	55	14	27	16	50	21	23	27	34	4	20	11
12	14	51	14	29	16	58	21	34	27	47	4	34	12
13	14	48	14	31	17	07	21	44	28	00	4	48	13
14	14	45	14	34	17	14	22	55	28	13	5	02	14
15	14	42	14	36	17	21	22	06	28	26	5	16	15
16	14	39	14	39	17	28	22	17	28	39	5	29	16
17	14	36	14	42	17	36	22	28	28	53	5	42	17
18	14	33	14	45	17	44	22	40	29	06	5	57	18
19	14	31	14	49	17	53	22	52	29	19	6	11	19
20	14	28	14	52	18	01	23	03	29	33	6	25	20
21	14	26	14	56	18	09	23	14	29	46	6	39	21
22	14	25	15	00	18	18	23	26	29	59	6	53	22
23	14	23	15	04	18	27	23	37	0 v	13	7	07	23
24	14	21	15	08	18	35	23	49	0	26	7	21	24
25	14	20	15	12	18	44	24	01	0	40	7	35	25
26	14	19	15	17	18	53	24	13	0	53	7	48	26
27	14	18	15	21	19	02	24	25	1	07	8	02	27
28	14	17	15	26	19	12	24	37	1	21	8	18	28
29	14	17	15	31	19	21	24	50	1	34	8	30	29
30	14	17	15	37	19	31	25	02	1	48	8	44	30
31	14	17	15	42			25	14		8	58		31

Defectus Lunaris Ulissippone a Do. Jacobeo Observatus Nov: 30. 1686.

	H. M.
<i>Initium</i>	8 02
<i>Immersio</i>	9 06
<i>Emergio</i>	10 50
<i>Finis</i>	11 57

Jovis a Luna tecti Observationes Grenovici habitæ a Jo. Flamsteedio Math. Reg. Martii 31. 1686.

	Temp. corr per hor. oscil	
	H. M. S.	
<i>Martii 31</i>	9. 32. 30	¶ s limbis tangebatur limbum Luna lucidum, Maetidis diametrum a termino ejus boreo.
	33. 42	¶ Totus tectus erat. Quantum per vapores horizontis & undulationem limbi valde turbidam, licuit conjicere.
	10. 11. 12	Differentia declinationum limbi Luna vere Austrini & loci Ingressus, Tubo ped. 8 & Micrometro 1546 = 12 m. 42 sec.
	30. 30	Jovis particula emergerat, e regione Borealis limbi Maetidis.
	31. 36	Jupiter totus liber.
	35. 50	Differentia declinationum centri Jovis, & limbi Luna Austrini 3436 = 28 m. 15 s.
	41. 40	Repet. 3585 = 29 m. 28 s.
	44. 00	Luna Diameter 3906 = 32 m. 07 s.
	45. 44	Repet. 3915 = 32 m. 11 s.

Accounts of Books. The Natural History of Staffordshire.

By Robert Plott L. L. D. Keeper of the Ashmolean
Museum and Professor of Chymistry in the Univer-
sity of Oxford.

There is very little need to take notice of the Method of this Work since it is drawn up according to the pattern laid down in the *Natural History of Oxfordshire* written some yeares since by our *Author*. He begins with the Heavens and Air, giving account of those unusuall Meteors, which have sometimes appeared in this Countrey; such are the *Solar Rain-bow* observed by Mr. *Wolverstan* Dec. 4. 1680. which appeared at first about the *Azimuth* of Two, two houres before the Sun, and thro the thin diaphanous clouds was mistaken for another sun, but soon after exhibited the Usual colour of a solar Rainbow: as also several Lunar *Iris's*, and very severe Winter Tempests. Here he takes an occasion to deduce the cause of the circles in Grasse called commonly *Fairy Walkes*, which he doth not think do owe their cause to the *Field Conventicles* of Demons and Witches nor to the subterraneous Courses of *Moles* and *Ants*, but rather to percussions made by Lightnings, which breaking out of the clouds in Concave Cones have made Circles on the ground conterminous to the Rims of those Cones, and according as the Cones breakeing forth from the clouds have had a greater or lesser inclination to the *Horizon*, and so have either touched with all the Base, or only dipt with the Lower part, have made Circles, or Quadrants, or Sextants &c. Here likewise he relates the wonderfull Raines, which have brought Frogs, whose Generation cannot (says he) be referred to the Ordinary way by seed *Cap. I.*

He then comes to treat of Waters and the Texture of Ambient Air, the Conservatory of all the Exhalations, which are perpetually forced by the suns heat out of the Earth; as

also of the wonderfull Intermittent Springs observed up and down in this country, which leads him to the Examination of the causes of the Rise of Springs and Wells, of which the World has had a Relation some time since, when we gave an Account of Dr. *Plott's* Latine Book *De Origine Fontium*, the Reasons whereof are here again at large repeated in *English*. Afterwards he particularly enumerates what Fountaines are Medicinal, as those at *Willowbridge*; what abound in Salt, as the Brine Pitts at *Weston*, which tho' inferiour to those in *Worcestershire* and *Cheshire* by reason of the weakenesse of the Liquor, yet after a tedious proceſſe to Cryſtalise the Salt, become very useful to the whole Countrey; and lastly, what are for Colour, or Taſt, or any other Accident, remarkable, as a Well between *Over* and *Nether Tene*, which in Autumn ſends up a great Quantity of ſmall Bones of Frogs, which creeping into thoſe Caverns, whence the Springs come, are killed by the cold; and the acidity of the water corroding the fleſh, thoſe Bones are driven up and carried away by the ſtreame of the Fountain. Cap. II.

From Waters our Author paſſes to Earths and Minerals: Of the firſt of which the Number is very great, eſpecially of fine Clays for Pottery-Ware and Bricks: But the Coale-Workes with the Iron-Mines moſt deſerve our conſideration. The Coale-Mines are very accurately deſcribed, both as to their Inclining Poſition, or Dipping under the ſurface of the Earth, and as to their ſeveral differences in goodneſs and uſefulneſs, ſuch are thoſe of *Cannal*, with which the Chaire of *Litchfield* Cathedral is paved; thoſe of *Wedneſbury* moſt fit for Culinary Fires, &c. Upon this occaſion the Nature of Damps is examined, which are reſolved into the ſtagnation of the Air contained within the Riſts of the Coale, that are emptied of the running Water (which in Virgin-Mines always fills the Riſts, and keeps them from this ſtaggating Air) by the *Soughes* made for that purpoſe; or which ſometimes are occaſioned by working ſo deep, as that thereby the Intervention of the upper Air is wholly ſtoppt. Cap. III.

Before we come to the Iron-stones, our Author considers those great Quarries of Marble, Alabaſter, and other uſefull ſtones diſperſed up and down the Country; all which he ſuppoſes to be made by a Petrification upon the meeting of the ſolutions of Aced and Alkalifate ſalts, which compound transparent, opake, and ſemiopake ſtones, as they are mixed with ſulphures or Earths of different fineſſes. He conſiders Pebles and Fireſtones by themſelves, as wherein the Sulphur is predominant; and therefore are they eaſely Calcinable. When he comes to the Iron-workes he explains the way how their Fornaces are built, how they melt their Iron-ſtone, how the goodneſs is diſcernable, and the like. As for the Copper-mines tried by Sr. *Rich: Fleetwood*, they would turn to no Account.

Other ſtones have been ſometimes found in *Staffordſhire*, which have had a determinate Form, as the *Aſteria* of a Pentagonall ſurface, with Rayes iſſuing from the Center, and to each angular point. Theſe are either ſuch as reſemble Animals or ſome of their Parts: ſo one was found like a Pullets heart, others like moſt Teſtaceous Fiſhes, which have been long thought to be petrified ſhells, tho ſome Naturaliſts are perſwaded to the contrary; or elſe ſuch as are like Vegetables, whereof in mineral ſtones and Oares there is great Variety. Gold Oare hath reſembled Branches of Trees, and *Wormius* had a piece of ſilver Oare exactly like a Vine; which Figures are ordinary in *Bohemia* as *Balbinus* informs us, and when he afterwards ſpeakes of the *Entrochi* and *Trochita* he explains very curiouſly ſeveral Figures not taken notice of by Mr. *Beaumont*. Cap. 5.

Next he comes to Plants, tho' there he owns little can be added to what Mr. *Ray* had found in his accurate Catalogue of *Engliſh* Plants, yet he found ſome few omitted by him, as a ſort of *Cup-Moſſe* with Scarlat Heads, and ſome *Fungi* [tho the *Fungus Phalloides* is deſcribed, and a *Cutt* annexed in the 2d. Edit. of Mr. *Rayes* Catalogue] together with ſome few Trees, which Mr. *Ray* took for ſtrangers

ers to our soil, as the Firrs, which Dr. *Plott* seemes to thinke are Natives here, which he grounds upon the great Numbers that have bin digged up in the *Mosses*, and can by no means be allowed to have bin under ground ever since the *Flood*; but were rather Trees, which being felled and not presently used, gathered and kept in the Rain Water, which in time bred there a Marsh, and being buried in earth by those frequent Deterrations from the adjoyning Hills, in time were so far covered, as we now see them. Some Trees he finds of wonderfull Growth in this Countrey, as the *Wiche-Elme* cutt down in Sr. *Harvey Baggot's* Park, that weighed near 100. Tuns: and that this may not be thought incredible, all the Demensions are sett down with Attestations of Workmen and of Sr. *Harvey* himself. Cap. 6.

Under Brutes, our Author comprehends all irrational living Creatures: amongst birds he takes notice of a Swan with Red Leggs, and a sort of *Colymbus* or *Ducker* not described by Mr. *Willughby*. the Pewet-Catching in *Norbury* Pond, with their way of Living, and their affection to the Family of the *Skrymsbeers* is exactly described. Of Insects he describes a water *Eruca*, a white Earwig and several more. He found amongst Fishes a *Mustela Fluvialis* with yellow spots, not observed by Naturalists. Speaking of Eels, he observes many which goe from one Pond to another in search of Provender, and then shews by the concurrent suffrage of Natural Historians, that it is no such strang thing; as is not also the finding of Toades in Trees and stones, whereof many instances are produced, which principally (says our Author) comes from a Toades being enclosed in a narrow Rift in winter, which afterwards closing too hard, imprisons them there, without killing them; Toads haveing little blood, and very viscous juices, require not much perspiration. In discoursing of sheep, he solves the Problem why the Testicles and Horns *se mutuo ponunt ac tollunt*, because those excrementitious juices which form hair, horns & wooll are more vigorously thrown out in Males than in Females, and

and in those when uncastrated, than when guelt; All a long, many Monsters and *Lusus natura* are described, and many cutt in Brasse. Cap. 7.

The Next Chap. is of men and women. And first he speakes of a man in *Stafford-shire* who married being 108 years of Age, and had a child extremly like him; next of a woman who had a Monstrous Birth, with a Bagg filled with *Grinder-Teeth*, and very hairy: of another woman who was brought a-bed without Knowing she was with child. [This Dr. Plott sayes is a case he never before met with, but it may be confirmed by the like instance of a young Woman, the wife of *Philip Barker junr.* of *Wrentham* in the County of *Suffolk*, who was also brought to bed of her second child, a lusty Boy, last Year, without any suspition of being with child; for about three days or a week before, she took Physick for a *Tympany*, which the good Women of her acquaintance perswaded her she was troubled with] Then our Author speakes of Famous men born in the County, as Arch Bishop *Skeldon*, Mr. *Ashmole* & c. And afterwards of those who are otherwise memorable for odd & occasional things, as the Boy of *Bilson*, who counterfeited being bewitched (where our Author takes occasion to differ very materialy from the old Relations); *Mary Foster* who recovering of a Fright, slept 14 days and nights: several deaf men who could understand what was said by the motion of the speakers Lips: then he mentions others eminent for Piety, particularly in building Churches, as Mr. *Chetwind* who built a noble Church at *Ingestre*, and others whose deliverances from dangers are very remarkable, as our Late Dread Sovereign K. *Charles* the seconds Preservation by Coll. *Lane* & c. Afterwards when he comes to speake of the Corporation of *Masons* he fully confutes the Fabulous Accounts, they give of their Charter Privileges; the rise whereof they date from St. *Amphibalus* alias S. *Albans Cloake*: he concludes with a numerous Catalogue of men and women, who have lived to an Extraordinary Age. Cap. 8.

In the next Chap. our Author treates of the most curious things relating to Arts in this County, such as in Water-Workes is the Jack turned by water falling vpon a Wheel after the manner of an Overshott Mill. So in Agriculture he examines all sorts of Compost, wherewith they emprove their Ground, as Marles, Lime-stones, Esse or Turf burnt to Ashes, and Turfes and Dung. He shewes what Land requires any Particular Compost; and what increase, when well manured, they usually produce. From Husbandry he passes to Buildings, where he describes the Cathedral at *Litchfield*, and upon account of its declination from East. towards N. he discourses of the reasons that enduced *Pagans* and *Christians* to build their Temples E.&W. He curiously describes the stairecase to the steeple of the Collegiate-Church at *Tamworth*, which is made with two *Cochlea's* winding one within the other round the same *Cylinder*, so that one may ascend in one *Cochlea*, and another in the other, unseen by each other: One *Cochlea* opening to the Church-yard and the other in the Church. He then tells of those curious Iron Works, Locks, Boxes, Spurs &c. for which *Wolverhampton* in particular, and this whole County in General is so much admired by strangers. Amongst other things he describes that remarkable Bridle for *Scolds* used in some parts of the County, which put into their mouths hinders their speakeing, and effectually shames them, whilst they are carryed over the whole Town where they live, thus Gagged.

Cap. 9-

The Antiquities in this County are either *British*, *Roman*, *Saxon*, *Danish* or *Norman*. Near *Wrottesley* there is a Ditch 4 Miles in Circumference, cross which there are to be seen Remainders of Streets, and here and there Foundations that seem to be of *British* Original; as also those Instruments of Stone like Darts and Arrow Heads, used by the *Britans*, which are here sometimes seen up and down. The Principal *Roman* Monuments are, *Watling-street*, and *Icknild-street*, which cross each other in this County, on which were the Stages where

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they lodged their Troops; as *Etofetum*, now *Wall*, and *Pennocrasium* now *Stretton*. In the *Saxon* time we find *Litchfield* raised by *Wlphere* K. of the *Mercians* to the Honour of St. *Ciadda*; *Wlphere* Castle at *Berry-bank* has yet some Ruines which are visible: *Tamworth* was K. *Offa*'s Seat; and *Wolverhampton*, or *Wulphrunes-Hampton*, called so from *Wulphrune* Wife to *Althelm* Duke of *Northampton* in K. *Edgar*'s Reign, was by her endow'd with a Deanary and Prebends; and several *Lows* or sepulchral Hillocks, raised by the *Saxons* are to be seen up and down, Marks of those Bloody Engagements between them and the *Danes*. There are no *Danish* Antiquity, more remarkable than their wooden Almanacks, still in use in *Denmark* and *Staffordshire*; one of which used in this County, our Author accurately describes, and explains its deviations from those now made in *Norway*. Lastly he clears many Customs and Tenures brought in by the *Normans*, as the Chusing the King of the *Minstrels*, and the *Bull-running* (instituted by *John of Gaunt*) at *Tulbury*, the claiming of the *Gammon* of *Bacon* at *Whitchmover*, and several others.

Cap. X.

2. *SCIOTERICUM TELESCOPICUM* or a new Contrivance of adapting a Telescope to a Horizontall Diall, for observing the moment of Time by Day or Night. by Will: Molineux Esq. R. S. S. Dublin. 1686 in 4to.

THE Author dividing his Book into XI Chapters, he first declares the Use & Advantage of this new Contrivance, which he conceives so great, that since the first mention of Dials, he hath not heard of a more plain and easy addition for their advancement; especially, when the Observation of the exact moment of time is so necessary, that neither *Geography*, *Navigatin*, or *Astronomy* can be brought to perfection, nor the Longitude or the Truth of *Astronomical* Tables.

Tables fully discovered. The Methods which commonly are used for observing the Moment of Time, are either by Dials, or by taking the Suns Altitude by day, or that of Stars by night ; or by observing the *Altitude* and *Azimuth* of the Sun or Stars ; or by the *Transits* of the Sun or Stars through the *Meridian*, or the coming of some Circumpolar Stars in the same Vertical with the Pole-Star. All which Methods are attended with many inconveniences and difficulties, the which our Author believeth his Way will avoid ; at least the most material ones, which commonly arise in the Practice. For whereas Dials must be very large, if there shall be any division for Minutes made discernable, so the uncertainty of the Shadow cast from a large Gnomon renders them useless for niceness, when also their service is only by Day, and when the Sun shineth. All which hindrances are taken off by this new contrivance of our Author, where also there is no need of any Calculation of Oblique Spherical Triangles, all being done by a plain and simple Observation, and by the Addition and Subtraction of two or three small Numbers; and that to such exactness, that not a quarter of a Minute, or 15 Seconds shall be wanting, performable also both by day or night. Describing therefore his Instrument in the 3^d. Chap. he tells, that the Contrivance consisteth in making a very large *Horizontal* Dial, adapted to the Latitude of the place where the Observation is to be made, capable of receiving divisions into minutes, and parts of a minute, fitted with a large, strong, and double Gnomon : He calls that a double Gnomon, that casts the Morning Shadow from its Western Edge, and the after-noon Shadow from its Eastern Edge, and the Noon-shadow by its thickness. This Dial is to be furnished with two pair of Sights or Rulers, one is to serve in the Morning, or for Stars on the Eastern side of the Meridian, the other to serve in the Afternoon, or for Stars on the Western side of the Meridian. Each of these consists of two moveable Rulers ; one he calls the *Horizontal Ruler*, the other the *Gnomonick*, or *Stile-Ruler*. These two Rulers must be

be so adapted that their two Edges, which are next to the *Gnomon*, may be perpetually in the same Plane with their correspondent edge of the *Gnomon*. On the Stile-Ruler he puts *Telescopicall Sights*, with Cross-hairs in their due place. This Instrument is represented by a large Scheme annexed to the end of the Book. How every part of this Instrument must be framed, and the Stile-Nut and Ruler-Joynt composed, is at large described in the 4th. Chapter. As for Telescopicall Sights, and their true adjusting; he tells Chap. 5. how to put in the *Mensurator*, or to place the intersection of the Cross-Hairs, so that they may stand neither too high nor too low, nor too much to the right or left Hand, which else would produce Errors in the *Azimuths* and *Altitudes*: also for making the *Line of Sight* or *Collimation* parallel to the sides of the Ruler, he applyeth two Pins, which will serve in the same manner for finding the Declination of the Magnet, whereas the Ways proposed by Mr. *Hanterville* and *Sturmius*, seem to be defective. The way of setting the Dial to his true Position, is explained in the 6th. Chap. where he tells that two things are requisite, first that the plain of the Dial be in an exact Horizontal Posture, by accurate Levels, and secondly, that the Meridian, or 12 a Clock-Line, be exactly towards South and North; for that being 12 minutes of a Degree ill placed, will make a Dial err a minute of Time, in the Latitude of 53 Degrees: and for this Reason he sheweth Chap. 7. how to find the Meridian Line by his Instrument, in taking several equal Altitudes of the Sun in the fore and afternoon, and having drawn the *Azimuths* thereto, the Bisection of the included Angles, will shew the true Meridian Line, which also may be found after the same manner at night by the Stars. But coming finally in the 8th. Chap. to the manner of observing the Time, after the Dial is justly levelled and stated; he shews it to be done by looking at the Sun through the Telescopicall or Stile Ruler, and bringing the Mensurator upon the Suns Center; and then the Horizontal Ruler shall cut the hour, minute, and part of a minute

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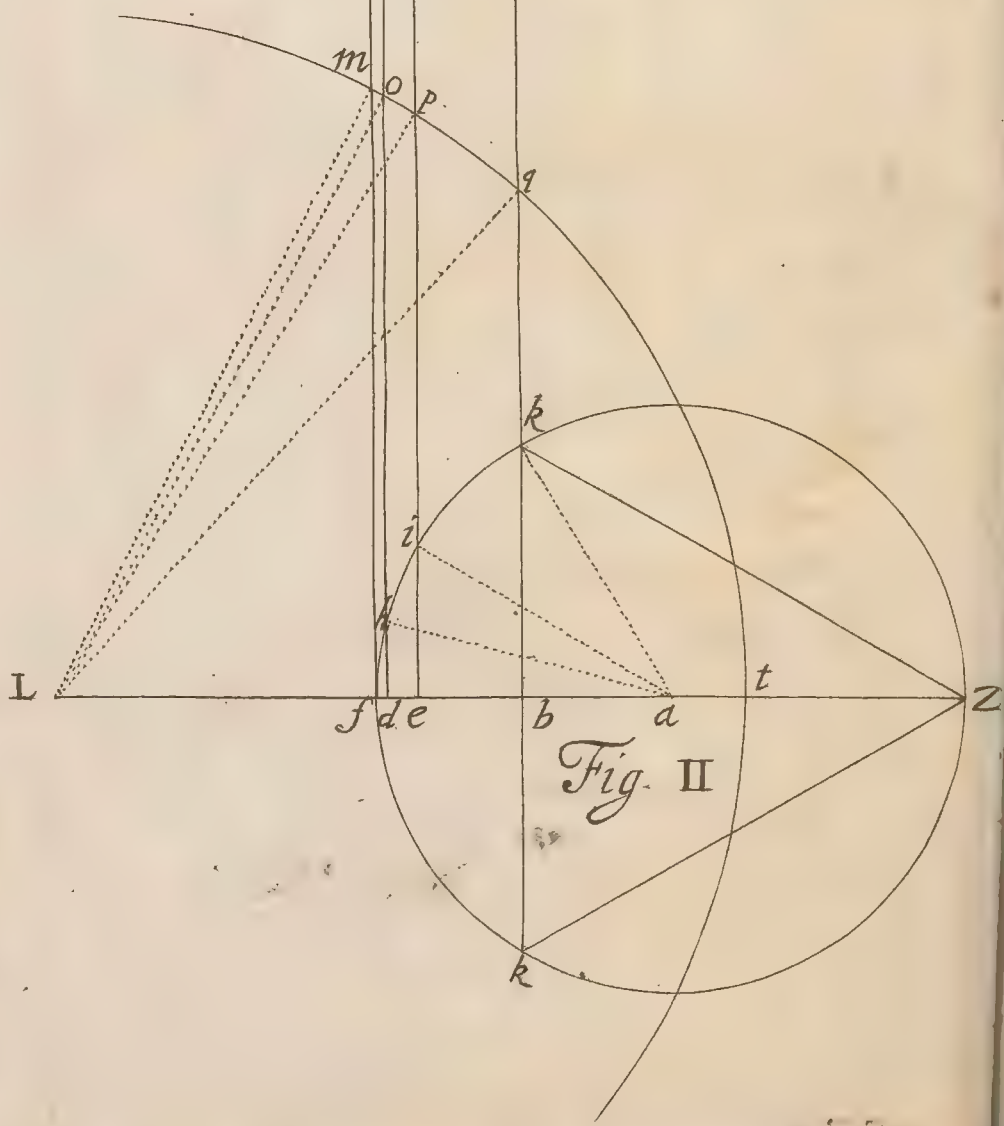
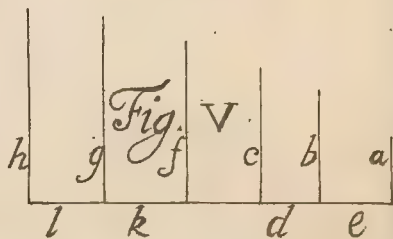
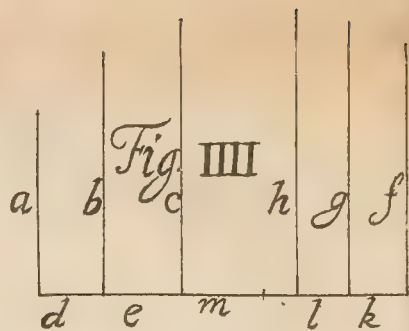
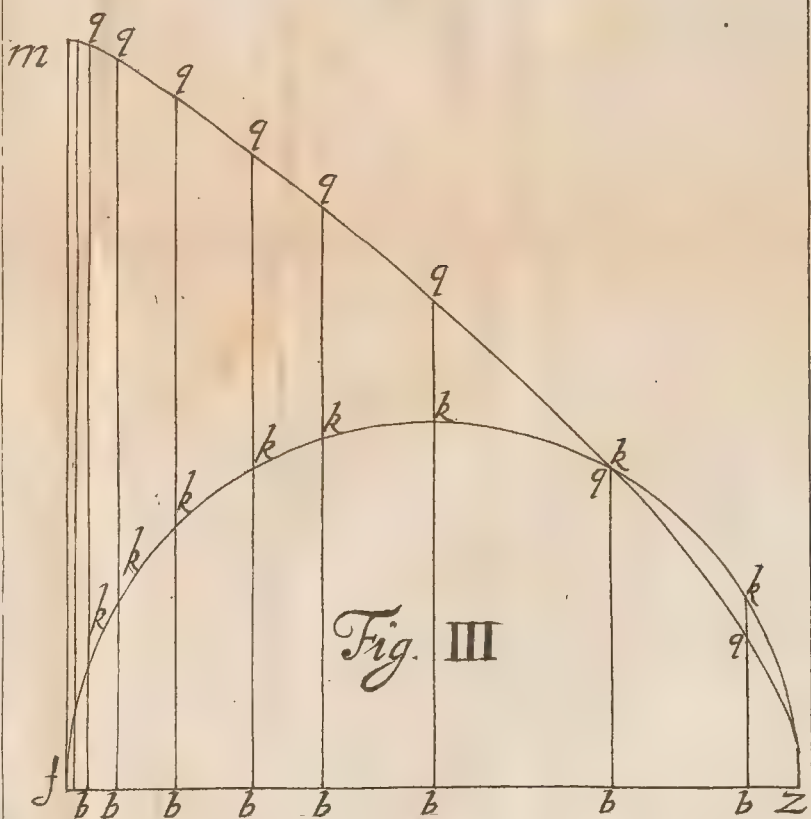
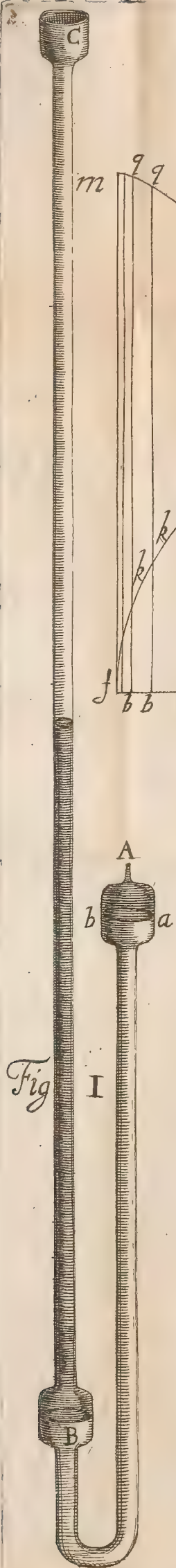
nute most exactly in the Dial. By the same Telescopic Sight, the motion of the Sun will be perceived so quick and nice, that two beats of a *Second-Pendulum* may be determined, and the time of the day or night to 3, 5, or 7 Seconds discerned. The way of using this Dial on the Stars by Night is much the same, only that for these are requisite certain Tables (put at the end of the Book) of the Sun and Stars temporary Right-Ascensions: For in looking at the Star through the Telescopic-Ruler, the Horizontal-Ruler cuts the Stars horary distance from the Meridian, to which adding the Stars Right Ascension, and from the sum subtracting the Suns Right Ascension, the remainder gives the Hour, Minute, and Second of the Night; and by this Method inverted, the Author thinketh the Right Ascension of any Star may be easily had. The way to calculate the Suns and Stars Ascensions, he declareth in the 9th. Chap. and also Chap 10, the Equation of Time, upon supposition of the equability of the Earths Revolutions; he shows also by a Calculus how to correct the length of the *Pendulum* of a Clock, and giveth in the 11th. and last Chap. Tables of the Circumpolar Stars their Calculation and Uses.

L O N D O N,

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Tab. II



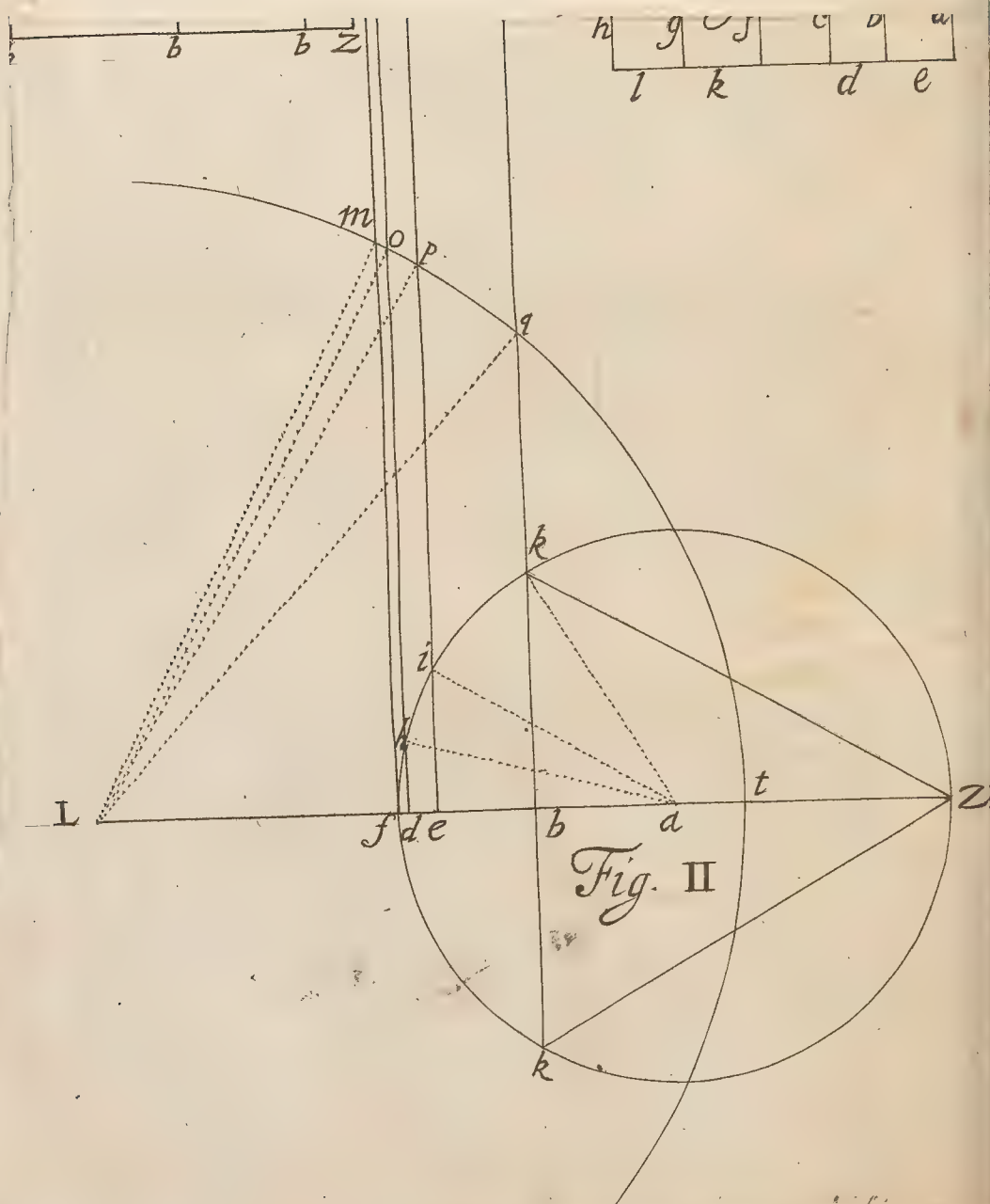
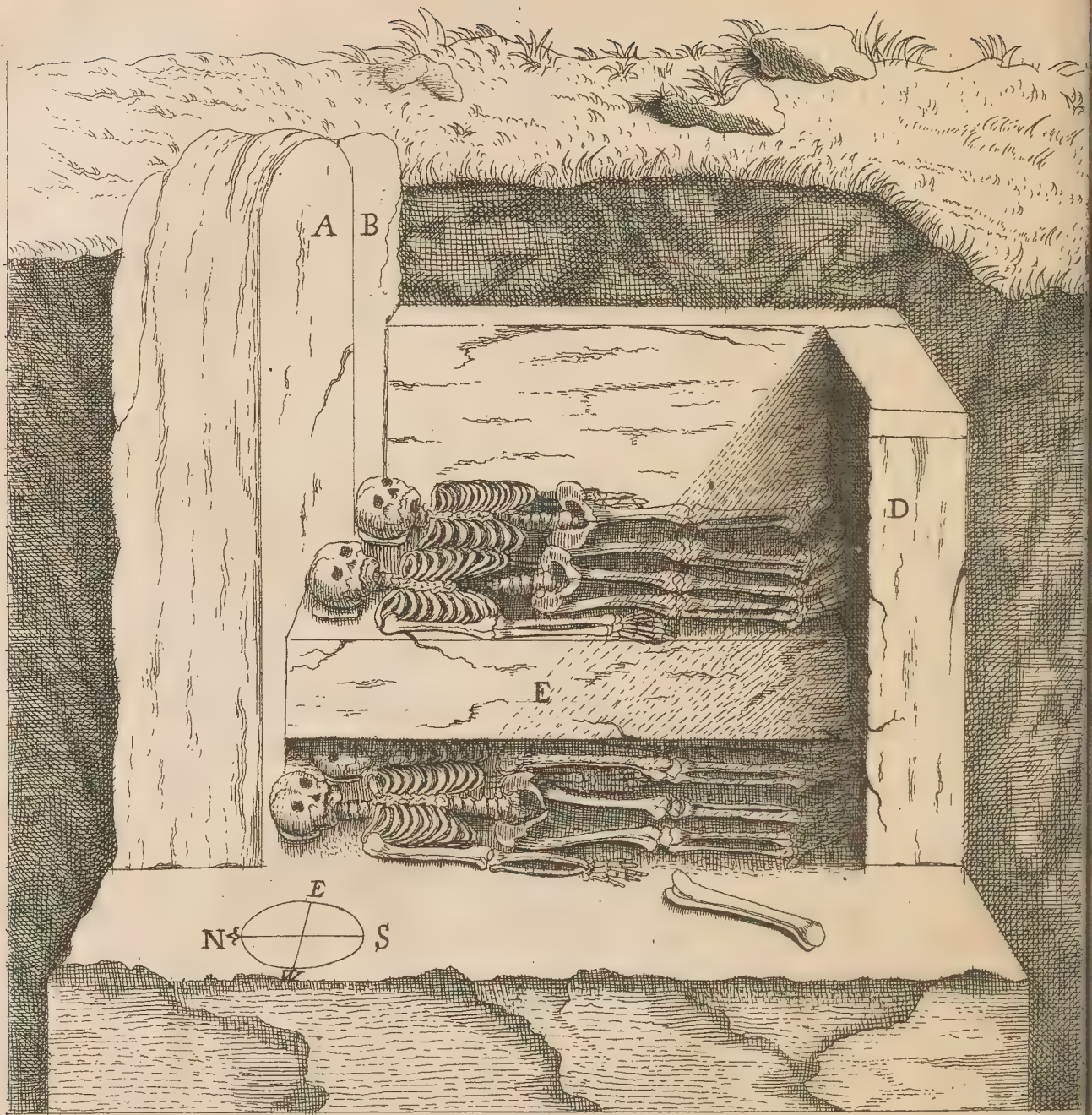


Fig. II

h	g	f	e	d	c	b	a
	l	k		d	e		



PHILOSOPHICAL TRANSACTIONS.

For the Months of November and December 1686.

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A Table shewing the time of High Water on the Coasts, and in the Ports of France, upon the day of the New and Full Moon. Taken from the French Ephemerides called La Connoissance des Temps for the Year 1687.

On the Coast of Gascony and Guienne.

At 3h. at the Mouth of Garonne, and the Isle of Ree.

At 3 $\frac{1}{2}$ h. at St. John de Luz, at Bayonne, and Memissan.

At 3 $\frac{3}{4}$ h. at Royan, Brouage and Rochelle.

At 3h. on the Coast of Poitou.

At 3 $\frac{1}{4}$ h. at Olonne and Beauvoir.

On the Coast of Britany.

At 1 $\frac{1}{2}$ h. at Bell Isle.

At 3h. at the mouth of the Loyre, at Garaude, Morbihan, Blavet, and Concarneau.

At 3 $\frac{3}{4}$ h. at Apenars, Vannes, and Auray.

At 2 $\frac{3}{4}$ h. at Apenmark, Audierne, the Race of Fontenay, and Le Conquet.

At 2 $\frac{3}{4}$ h. at Brest, and at Cape de Four.

At 4h. at St. Paul de Leon.

At 4 $\frac{1}{2}$ h. at Port Blanc.

At 6h. at St. Malo and Cancale.

On the Coast of Normandy.

At 7h. at Granville, and Barneville.

At 8h. at Cherbourg and Barfleur.

At 9h. at Caen and Honfleur, at the Mouth of the Seine, and at Havre de Grace.

At 9 $\frac{3}{4}$ h. at Fescan and St. Valeri.

At 10 $\frac{1}{2}$ h. at Rouen, Dieppe, and Treport.

On the Coast of Picardie.

At 11h. at the Mouth of the Somme, at Estaple, Boulogne, and Ambleteuse.

At 11h. at Calais.

At 12h. at Dunkerk, Newport and Ostend.

The Verbal Proceſs upon the Diſcovery of an Antient Sepulchre, In the Village of Cocherel upon the River Eure in France.

IN the yeare 1685. the 11th. day of *Iuly*; Wee *Olivier Eſtienne* an Advocate in Parliament, ſubdelegated by *Monſieur de Marillac*, Concellour of State in ordinary, having the conduct of the workes that are making upon the River of *Eure* below the Village of *Paffy*, Doe Certiſie to all preſent and to come, that upon the petition of *Meſſire Robert*, Prevost of *Cocherel*, Knight and Lord of the Mannour of the upper and lower *Cocherel*, wee have this day come to the ſayd town of *Cocherel*, having with us ſeveral Witneſſes, and from thence to a piece of Land of the ſayd Mannour of upper *Cocherel* called *les Hautberges*, upon the top of a riſing Ground expoſed on all ſides to the Sunn, a little declining from South to Weſt. Where being come the ſayd Lord of the Mannour of *Cocherel* did remonſtrate unto us, that having occaſion for a conſiderable quantity of Free-Stone for the reedification of the gate or Sluice for boates of the Mills of *Cocherel*, and which hee is to reſpaire by the Kings order, hee had for that purpoſe cauſed two great Sones, which appeared in this place above ground onely as two Limits or Bounds, the one about a foot and the other about 8 or 9 Inches to be further uncovered, and they had been found to bee 6 foot heigh, and about a foot and a half thick; marked in the figure of the Sepulchre A and B; the bredth of the one marked A of three foot, and the other marked B of two foot and a half, ſet end ways by one another; and they had further obſerved in making this diſcovery, that it was an Antient Sepulchre, ſhut only on three ſides, viz. at one end at the head by the two Stones already mentioned; on the right ſide by a Stone placed edg-ways upon its thickneſs of about 14 Inches, and being above 5

E e

foot

foot and a half long, and about 3 foot broad, touching in a Right Angle the Stone marked B at the head; and at the feet another Stone was set, it was marked D, of the same thickness of the precedent, and about 4 foot square; all these Stones were cemented together with Morter made of the Chalk or Marle taken out of the same hole, and mingled with little Stones or Gravel.

That in this Sepulchre were found the Bones of about twenty Bodies of Men, of the ordinary Stature, between 5 foot and a half, and 6 foot, except two Youths of about 15 or 16 Years old; all these Bodies lay extended North and South, the Arms along the Bodies, and the Heads all placed along the two Stones A. B. In the Right Angle there were two Bodies separated from two others by the Stone E, of about a foot thick, 4 foot broad, and 5 foot and a half long, that lay in the manner of a Tomb Stone upon the two Bodies underneath. All these heads had very fair sound Teeth in them, and the *Cranium* and other Bones of the Head, were much stronger and thicker than those of ordinary Heads; which argues them to have been of strong well constitution'd Men; amongst them all there was not any Womans Head.

In proceeding still to examine the Sepulchre, we did observe, that at the same distance from the Superficies of the Earth, and from those Bodies thus buried, there was three little earthen Pots, of about 4 Inches Diameter, and between 4 and 5 Inches high, of a black Earth as soft as Wax; which could not be separated from the other Earth without breaking them, and the peices being come into the open Air turn'd of a greyish Colour and grew hard: These Pots were full of Wood Coals and Ashes, which were not much examined.

All these large Stones of the Sepulchre were rough, and had not been cut, but seem'd to have been fetcht from a Neighbouring Quarry, which is about 400 foot off, upon the same Hill.

We

We observed besides, that in the place where were laid the two Heads of the Bodies, that lay upon the Tomb-Stone E there were found two Stones: The one whereof was about 6 Inches long, and some 15 Lines broad in its broadest place, and about 4 Lines thick; fram'd like the head of a Pike, very sharp and cutting at both ends and on the sides; it was a yellow Flint, of which the best Fire-lock Stones are made, being almost as hard as an *Agat*. The other Stone, which was likewise under one of these Heads, was shap'd like the head of an Axe, about 4 Inches long, and 3 Inches broad, having a hole at the narrowest end, and about 6 Lines thick, very sharp and of a greenish Stone, spotted with white spots as hard as *Agat*: the *French* Lapidaries call it *Pierre de Jade*, or the *Nephretick* Stone.

Under the two Heads which were under the Tomb-Stone E, there were also found two other Stones; the one much of the same Nature with that first described, but something longer, and the sharp end a little dull'd. The other was likewise in the shape of an Axe Head, very sharp and cutting, of about 3 Inches long and 2 and a half broad, and 6 Lines thick, with a hole in it at the narrow end: The Stone was of a dark green Colour, which the Lapidaries call, *Oriental Serpentine*.

On the left side of the Sepulchre which was open, there were sixteen Bodies in the same Situation as the first, placed North and South, their Heads along the great Stone A, and the Arms extended along the Bodies, the Bones all entire, though they appeared very Antient, and after two Days lying in the Air fell all to Dust.

All the Bones of these heads, as has been said before, were very thick, there was one that had been pierced by some blow, and Nature had repaired the Wound; within, the hole was round as having been made by some sharp round Weapon, which argued likewise the wounded to have been a Souldier. Under every one of these heads, there was a little Stone: Two were round, one of a reddish colour, of about

an inch thick, having a hole at each end, which lessened and grew narrower towards the middle. Another of a Chesnut colour and about the bigness of a Chesnut, made in the shape of a Coat-button, with a hole clean through it, but roughly polished and hard, seeming on one side to have suffered by the fire.

There were likewise two other little Stones, which according to probability were under the Heads of the young Bodies ; whereof one was about two inches long and eight lines broad and two lines thick, pretty sharp at the broader end, and having a hole at the narrow end : it is thought to be of the same *Pierre de Jade*, green and white, but tis nothing neer so hard as the first.

The other Stone was about 17 lines long, and 8 broad, two lines thick, somewhat sharp at the broad end, and having two holes at the narrow end, the one bigger than the other : tis thought to be of a white Marble or Alabaster.

There were moreover found under these Heads three Stones, whereof two were of a grey Pible, such as we find by the Sea side, shaped like Axes Heads, sharp and polished, about four or five inches long and four broad at the broadest end, about an inch and a half at the narrowest, and in the middle about an inch thick. These Stones were by their narrow end to be put into a piece of Staggs Horn fitted to receive them, as appeared by several pieces found in this Sepulcher, which had an oval hollow at the end to receive one of these Stones, these pieces were about six inches long, and had a hole at the other end, by which they might be fastened to a longer stick.

The Third Stone was of the shape of the precedent, but of a black Pible like a Flint, of which this Country is very full ; and it was besides remark'd that the pieces of Staggs Horn were worn at the end, and polished upon some Stone, but not cut with Iron.

Under all the other Heads there were ten little Stones like black flint, one under each Head, cut all in the same shape

shape, smooth on one side and sharp on the other; tis thought they might use them as Knives.

There was likewise found in the same place under one of the Heads a Stone, which within was of black flint, having the outside of a white substance, as that sort of Stone uses to be, this had two Eminences like Teeth, which we took to be Natural, and not Artificial. All these Stones thus placed under their heads shewed that they had them in great Esteem.

Amongst these dead Bodies has been also found some Bones sharpened, to put at the end of a Stick, or at the end of an Arrow; one was of the smaller Bone of a Horses Legg, and the other was made of the sharp end of the Andouilleres of a Staggs Horn.

Amongst all these Stones there has been found no sort of Inscription, Sculpture or Character either in *rilievo* or otherwise, which might oblige us to think that these Men had any knowledge of Christianity; but rather that they had some Idolatrous Superstition, as these Stones seemed to Indicate. Wherefore we thought fit to declare to the said Lord of the Mannour of *Cocheret*, that he might without Scruple use these Stones for what use he thought fit.

Since the Expedition of the present verbal process, there having been further digging on the left side of this Sepulcher, it has been discovered that the bottom of the Sepulcher was raised, and not so deep by a foot and a half as that part where the Bodies were buried. And it is perceivable that in this place several Bodies have been burnt, whose Ashes and burnt Bones have been thrown confusedly into this hole: and 'tis observable that all along the Sepulcher, there is a veine of Coales and Ashes, which runs about two foot below the superficies of the Earth, and all these Ashes, and Bones are under this Bedd of Coales and Ashes which are so salt and, ungent that they make one sneeze; and when these Bones are handled they produce a tingling in ones fingers ends, as if one had handled the sharpest Salt-Peter.

There

There has not been time yet to finish entirely this discovery by digging into the Earth that has been put into this Sepulcher, which was digged on purpose in the Chalke to bury these Bodies, and likewise the Ashes and Bones of those others that were Burnt. So that it seems difficult how to reconcile the two Cerimonies of Burying and Burning. Except we should say that there has been a fight in this place between the *Gaules* and some barbarous Nation, who had Invaded them; that the *Gaules* have burn't their dead, and sacrificed to the *manes* of them their Prisoners taken in Warr, whom they buried with the Cerimonies proper to those Barbarians, the thickness of whose Sculls shew that they went bare-headed; and their Armes shew that they had not the use either of Iron or Brass to make Arms of, but using such as Nature afforded first, as some *Indian Nations* do now.

There remains now to guess, by these Stones and what Antiquities we have left in History, who these *Barbarians* should be, and at what time this Sepulcher might be made.

The Sepulchres and Monuments of the Dead having been in all times held sacred, and it being lookt upon as a piaculum to remove or deface them: Mr. de Cocherel having discovered this but now described, thought it his duty to inquire into the Condition thereof, as not being willing, without Legall Authority, to disturb the Bones of those there interred: This was the occasion of this Verbal Process, which for the Novelty of the thing, was thought fit to be Published in the form of Law, as it was communicated by Mr. Justell. Reg. Soc. S. who has promised to procure, if possible, the Figures of the Arms of Stone found in the said Sepulchre, which in some following Transaction shall be given.

*An Extract of a Letter Written from Rome, dated the
16th. of November last, to Signior Sarotti, concerning
a Discovery made upon the Inundation of the Tevere.
Translated out of the Italian.*

I Believe you have already heard how the Inundation of our River has done several considerable Mischiefs all about this City, spoiling several fine Houses, and very large Aqueducts, by breaking down their conducts, &c. It has in several Places, (especially without this City) by breaking the Ground, discovered Vaults unknown before, great part of them full of earthen Urnes, and Sepulchers, but of no great consideration, by the Inscriptions they had upon them: Only in a Place within two Miles of this City, where there was some great antient Ruines, the Water having pierced a strong thick Wall which joyned to a great Country Palace, and passing under the same, broke out at a corner of an Aqueduct by the said House, where there was found a small Vaulte of an Oval Figure, in which there was a Stone Sepulcher pretty large, with the following Inscription P. M. R. C. *cum Uxore*. and more, which could not be discerned; By this same there was a great earthen Urne shut up very close, which being opened, there came out such a strong Smoake, that it made the Man that was by it almost giddy; the Smell was like Bitumen, but being quickly dispersed, they found in the bottom of the said Urne an earthen Pot made up as a Lamp, full of a *Materia Oleosa*, which by degrees, as the cold Air got into it, grew hard.

Several persons suppose this to be one of those perpetual Lamps that the Antients mention: For my part, I cannot give yet my Iudgment; but after that the business shall be better examined, I shall give you a further Account of it; intending to go my self to see it, because the Gentleman in whose Palace it was found is my good Friend.

*A Relation of a petrified Glandula Pinealis, lately found
in the Dissection of a Brain : Communicated by Sr. Ed-
mond King Knt. M. D. and Reg. Soc. S.*

Mr. **R**OBERT BACON, Master of Arts, of *Corpus Christi* Colledge in *Oxford*, a Pious Learned Man, above 75 Years of Age, was formerly employed in Transcribing and Publishing the posthumous Works of Dr. *Robert Gell*; he had been before a Preacher at *Busleton*, near *Bristol*, and afterwards in the Town of *Windsor*; he was Sanguine, and chearful in his natural Temper.

About 12 Years since, his Friends observed that at his return home from walking, he would bend double to his right Side, infomuch that he would be ready to fall, and has been brought home in Coaches and Sedans, yet was always temperate, and never observed to be disordered with Drink in his Life.

He would often say, that he feared Fatuity, or Distracti-
on, and would pray that God would keep him in his right
Mind.

His Appetite to all sorts of Food in his latter Years incli-
ned to Canine, and his Thirst very great.

He often complained of pain in his Bowels.

He was always desirous to have his Head rubb'd many
times in the day, and this too was of late Years.

His Urine of late Years, and Excrement came away al-
ways involuntary at Bed, Board, &c. of which he did not
seem at all to be sensible.

Of late he would always hang down his Head in a prone
sleeping Posture; and his Head was very hot: he did sweat
very much every night, and wet his Linnen extraordi-
narily.

And in the whole his rational Faculties seemed to be quite
lost, for a great while before he dyed; for he would usually
take

take up Tongues, Fire-shovel, Brooms (many times alltogether) to walk by, though he had a Staff of his own ; he would also hale the Chairs about the House and up the Stairs, and grasp at any thing with his hands; he would often tumble on the ground, and seldome rise without help; he did rather creep along by Walls and Chairs than go, though formerly he went very upright ; of late it was 2 or 3 Folks Work to support him to his Bed ; he would put 2 or 3 Hatts at a time upon his Head like an Antick, he would many times strike those that attended him, yet at Intervals would say to his Daughter, *Pray thee be reconciled to me,* or words to that Effect.

I hearing of these things before this Gentleman dyed, desired that I might open his Head, and examine the Brain to see what I could find or observe therein extraordinary, that might occasion so great a Change as was in him some Years before his Death.

He dyed of a *Feaver*, *November* the 4th. 1686, about 6 in the Evening.

Nov. 6th. 1686.

Upon Dissecting the Body of Mr. *Robert Bacon* aforesaid ; We found in the lowest *Venter* as followeth.

The Liver indifferently well coloured and firm.

The Spleen firm and good, but shrivill'd.

The Stomack firm, large, and strong.

The Intestines all well coloured.

The *Omentum* whole but ill coloured.

The *Pancreas* very firm and good.

The Mesenterie well enough.

The right Kidney sound, with a few small stones.

The left Kidney two parts of three wasted, and some

F f

course

course Gravel, but both Kidneys very fatt.

The Bladder of Gali fill'd with one Stone only, and that no bigger than a long Nutmeg.

The Bladder of Urine found, but some little course Gravel and small Stones in it.

The middle *Venter* being opened; the Lungs were well enough, only by the stagnation of Blood discolour'd, and fill'd in several places with Icorous Spumy Matter.

The Heart strong and Vigorous as I have seen.

The Pericardium very thin, and too tender, and too little Water in it; very little Blood in the Ventricles: No adhesion of his Lungs to his Ribbs.

The Auricles of his Heart perfectly found and strong, as of any found Man of 20 Years old; those and the strength of the Muscles of the Heart I admir'd

The Head being opened,

The *Dura Mater* extreamly hard, thin and white, a slender Imboydery of Vessels.

The *Pia Mater* all full of seeming turgid Glands, and a great distention of Lymphæducts full of coagulated *Lympha*.

The substance of the Brain loose and shrunk, very white, very little of the cineritious Colour to be seen.

The *Corpus Callosum* very flaccid more than ordinary.

The whole Body of the Brain was shrunk about a third part.

Between the two *Meninges* of the Brain, was near a pint of extravasated *Serum*, that must needs oppress the Brain very much.

The Ventricles of the Brain full of *Serum*.

The *Plexus Choroides* extreamly large, in length as well as breadth and thickness.

The *Nates* and *Testes* very small, and shrunk.

The *Thalami Nervorum Opticorum* plump and fair.

The

The *Corpora Striata* large and fair, full of large *Striae* as I have seen.

The *Glandula Pinealis* firm and fair, well colour'd to look on, of the exact Figure, and ordinary size: Feeling of it, and finding it harder than ordinary (and talking to a Gentleman then present of *Des Cartes* his Opinion, that it was the Seat of the Soul) I prest it, and found in it a Stone in a film, or rather a petrified Gland in a film; I took out the Stone, and kept it as a great Raritie; I do not remember I ever heard of such a thing before, I am sure of all the Brains I have dissected (and I may say I have dissected more than an hundred) I never saw such a one.

The *Glandula Pituitaria* was half wasted, that part that was left was very hard and brittle, had not the Tone of a true Gland, nor substance, according to my Observations, unless of a vitiated Gland.

The *Cerebellum* seem'd well enough, and all down the *Cauda Medullae oblongatae*.

The other parts of the Brain unmentioned had nothing remarkable, nor have I time now to Philosophise upon the Remarques to be made upon the above-named Observations.

Before he became so mopish, he would say he felt a certain kind of fierceness within him, which (it is probable) made him to utter some kind of Vociferation when he was displeased at any thing.

Remedies were applied to all these Distempers for several Years, both inward and outward; outward as in Plaisters, Cerates, opening the Jugular, &c. inward as Cardiacks, Cephalicks, and Febrifuges, &c.

Thus having told you Matter of Fact, attested by his own Relations, (who were Eye Witnesses of it) I leave these my Observations upon the Dissection of his Body to the Consideration of the more Curious and Inquisitive.

Edm. King.

November the 6th.

1686.

A Correct TIDE-TABLE, shewing the true times
of the *High-Waters* at *London-Bridge* to every Day in
the Year 1687: By *J. Flamsteed* Math. R. & R. S. S.

January.				February.				March.				
D.	Morn.		After.		Morn.		After.		Morn.		After.	
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	11	52			1	19	1	50			0	33
2	0	29	1	05	2	17	2	40	1	04	1	33
3	1	37	2	07	3	01	3	21	2	01	2	23
4	2	34	2	58	3	39	3	56	2	44	3	03
5	3	20	3	41	4	12	4	28	3	20	3	36
6	4	00	4	18	4	45	5	03	3	52	4	09
7	4	36	4	54	5	23	5	44	4	26	4	44
8	5	14	5	34	5	07	6	33	5	02	5	24
9	5	56	6	20	7	00	7	31	5	47	6	13
10	6	43	7	09	8	02	8	35	6	39	7	08
11	7	37	8	05	9	08	9	42	7	39	8	13
12	8	36	9	08	10	17	10	51	8	47	9	21
13	9	42	10	15	11	24	11	56	9	54	10	26
14	10	49	11	21			12	25	10	57	11	26
15	11	54		0	52	1	16	11	56			
16	0	25	0	52	1	39	2	00	0	22	0	47
17	1	16	1	41	2	19	2	37	1	10	1	32
18	2	06	2	26	2	53	3	08	1	52	2	10
19	2	45	3	02	3	22	3	36	2	28	2	45
20	3	18	3	32	3	50	4	03	3	00	3	16
21	3	46	4	00	4	17	4	32	3	31	3	47
22	4	13	4	28	4	48	5	06	4	03	4	20
23	4	43	5	58	5	26	5	49	4	37	4	57
24	5	14	5	31	6	14	6	43	5	20	5	45
25	5	51	6	12	7	18	7	53	6	13	6	44
26	6	36	7	03	8	31	8	11	7	19	7	55
27	7	33	8	07	9	54	10	36	8	35	9	15
28	8	42	9	20	11	18	11	56	9	55	10	34
29	10	02	10	42					11	10	11	44
30	11	24								0		16
31	0	04	0	44					0	47	1	15

April.				May.				June.				
D.	Mor.		After.		Mor.		After.		Mor.		After.	
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
1	1	40	2	03	2	00	2	24	3	05	3	24
2	2	25	2	44	2	44	3	04	3	41	3	58
3	3	02	3	20	3	23	3	41	4	14	4	32
4	3	38	3	55	3	59	4	17	4	49	5	07
5	4	11	4	30	4	35	4	53	5	26	5	46
6	4	49	5	10	5	13	5	35	6	05	6	26
7	5	33	5	58	5	59	6	24	6	48	7	11
8	6	24	6	51	6	49	7	15	7	34	7	59
9	7	21	7	52	7	40	8	07	8	25	8	51
10	8	22	8	52	8	34	9	01	9	19	9	47
11	9	23	9	53	9	29	9	58	10	18	10	50
12	10	22	10	50	10	25	10	51	11	23	11	56
13	11	18	11	43	11	18	11	44		0		28
14			0	10			0	11	0	59	1	32
15	0	35	0	58	0	39	1	06	2	01	2	28
16	1	20	1	42	1	32	1	56	2	52	3	14
17	2	03	2	23	2	20	2	44	3	36	3	56
18	2	41	3	00	3	06	3	26	4	17	4	37
19	3	18	3	37	3	46	4	06	4	57	5	19
20	3	55	4	14	4	26	4	49	5	41	6	05
21	4	34	4	55	5	13	5	38	6	30	6	56
22	5	19	5	45	6	06	6	33	7	22	7	50
23	6	15	6	47	7	01	7	31	8	20	8	51
24	7	20	7	54	8	02	8	34	9	21	9	55
25	8	30	9	04	9	05	9	35	10	28	11	03
26	9	39	10	13	10	07	10	38	11	36		
27	10	46	11	19	11	08	11	41	0	08	0	41
28	11	49					0	11	1	08	1	36
29	0	18	0	45	0	41	1	08	2	00	2	23
30	1	13	1	38	1	35	2	00	2	44	3	03
31					2	24	2	45				

July.				August.				September.				
D	Mor.		After.		Mor.		After.		Mor.		After.	
	H	M	H	M	H	M	H	M	H	M	H	M
1	3	20	3	36	3	54	4	07	4	29	4	44
2	3	51	4	06	4	21	4	35	5	01	5	21
3	4	02	4	35	4	49	5	05	5	44	6	09
4	4	50	5	06	5	22	5	40	6	37	7	08
5	5	23	5	39	6	02	6	26	7	44	8	22
6	5	59	6	19	6	51	7	19	9	01	9	42
7	6	39	7	02	7	52	8	26	10	22	11	02
8	7	27	7	54	9	04	9	44	11	42		
9	8	21	3	50	10	25	11	06	0	18	0	50
10	9	02	10	06	11	46			1	18	1	46
11	10	44	11	21	0	25	1	00	2	12	2	33
12	11	59		1	34	2	02	2	53	3	14	
13	0	36	1	11	2	27	2	49	3	29	3	46
14	1	43	2	13	3	09	3	27	4	03	4	21
15	2	39	3	03	3	45	4	01	4	40	5	00
16	3	24	3	42	4	18	4	35	5	22	5	47
17	4	00	4	18	4	53	5	14	6	14	6	42
18	4	36	4	54	5	35	6	07	7	13	7	45
19	5	13	5	33	6	26	6	53	8	18	8	52
20	5	56	6	20	7	25	7	58	9	27	10	01
21	6	41	7	12	8	33	9	08	10	33	11	07
22	7	40	3	15	9	43	10	19	11	31	11	58
23	3	50	9	24	10	54	11	26		0		23
24	10	02	10	33	11	58		0	47	1	10	
25	11	08	11	42	0	26	0	53	1	31	1	50
26		0	15	1	17	1	4	2	08	2	26	
27	0	45	1	14	2	00	2	19	2	42	2	57
28	1	39	2	03	2	36	2	51	3	13	3	28
29	2	23	2	41	3	06	3	19	3	43	3	58
30	2	57	3	13	3	33	3	4	15	4	33	
31	0	27	3	41	3	59	4	13				

October.				November.				December.			
D.	Mor.		After.	Mor.		After.	Mor.		After.	Mor.	
	H.	M.	H. M.	H.	M.	H. M.	H.	M.	H. M.	H.	M.
1	4	52	5	14	6	29	6	59	6	57	7
2	5	38	6	05	7	31	8	05	7	55	8
3	6	35	7	07	8	39	9	12	8	57	9
4	7	42	8	20	9	45	10	19	10	02	10
5	8	57	9	36	10	51	11	23	11	06	11
6	10	14	10	51	11	05	4			0	04
7	11	25	11	58	0	25	0	53	0	42	1
8		0		30	1	20	1	46	1	41	2
9	0	59	1	26	2	10	2	33	2	31	2
10	1	50	2	14	2	55	3	14	3	12	3
11	2	35	2	55	3	34	3	52	3	04	4
12	3	14	3	32	4	11	4	31	4	21	4
13	3	50	4	09	4	05	5	11	4	56	5
14	4	28	4	48	5	33	5	56	5	29	5
15	5	10	5	34	5	20	6	43	6	09	6
16	6	00	6	27	7	08	7	33	6	50	7
17	6	56	7	25	7	58	8	25	7	34	7
18	7	54	8	23	8	51	9	16	8	02	8
19	8	54	9	23	9	42	10	09	9	19	9
20	9	53	10	19	10	03	11	02	10	19	10
21	10	47	11	13	11	28	11	56	11	24	11
22	11	40					0	23		0	32
23	0	05	0	29	0	50	1	15	1	04	1
24	0	52	1	14	1	41	2	06	2	02	2
25	1	36	1	55	2	29	2	52	2	05	3
26	2	16	2	35	3	12	3	33	3	34	3
27	2	53	3	11	3	05	4	11	4	12	4
28	3	27	3	45	4	33	4	55	4	50	5
29	4	03	4	25	5	17	5	41	5	29	5
30	4	46	5	08	6	06	6	30	6	16	6
31	5	53	6	02				7		08	7

new

*Eclipsis Lunæ Observata Dublinii, Novembris 19^{no}.
1686. a Dno. Gulielmo Molineux Reg. Soc. S. & ab
eodem Regiæ Societati communicata.*

	H.	M.	S.
<i>Penumbra notabilis</i>	9	15	00
<i>Initium ob interpositas Nubes præcise de-</i> <i>terminare hæud licuit, ideoq; incertius pono</i>			
<i>Eclipsin incepisse ad 9 h. 25 m. vel</i>	9	27	00 *
<i>Umbra ad Paludem Maraotim</i>	9	38	20
<i>Palus Maraotis tecta</i>	9	40	20 *
<i>Mons Sinai Tegitur</i>	9	46	30 *
<i>Mons Thambes Tectus</i>	10	1	20 *
<i>Mons Audus Tegitur</i>	10	8	00 *
<i>Mons Neptunus Tectus</i>	10	14	00 *
<i>Umbra ad Montem Sipylum</i>	10	15	10 *
<i>Insula Circinna tegitur</i>	10	16	40
<i>Ad Montem Didymum</i>	10	18	20 *
<i>Mons Didymus tegitur</i>	10	20	10
<i>Emergit M. Audus</i>	10	23	00
<i>Umbra ad paludem Maraotim.</i>	10	48	30
<i>Emergit Maraotis</i>	10	52	00
<i>Ad Montem Sinai</i>	11	38	00
<i>Emergit Sinai</i>	11	39	30
<i>Finis Eclipsis</i>	12	4	00

Notanda.

Tempora sunt Horologii Oscillatorii ad Stellæ fixas rectificati.

*Quæ Asterismo Notantur Observationes, per hiantes Nubes cap-
tae sunt, adeoq; accuratas haberi nolo.*

Quantitatem hujus Eclipsis sex puto Digitorum.

*Calculum quod spectat, in Initio determinando, Ephemeridas
Gallicæ (La Conoissance des Temps) ad veritatem propius
accedunt quam Anglicæ (Societati Regiæ dicatæ) Illæ enim I-
nitium*

Initium ponunt ad 9h. 31m. hæc vero ad 9h. 38m. Meridianorum habito respectu.

In assignandis autem Medio, Fine, Quantitate & Duratione Ephemerides Anglicæ Gallicis sunt accuratiores; Finis enim ab Anglicis ponitur ad 12h. 14m. a Gallicis vero ad 12h. 29m. Quantitas ab illis supputata sex fere Digitorum; ab his 7¹ Dig.

A further Assertion of the Propositions concerning the Magnitude, &c. of London, contained in two Essays in Political Arithmetick; mentioned in Philos. Transact. Numb. 183; together with a Vindication of the said Essays from the Objections of some Learned Persons of the French Nation, by Sr. W. Petty Knt. R.S.S.

1. **I**T could not be expected that an Assertion of *Londons* being bigger than *Paris* and *Roven*, or than *Paris* and *Rome* put together, and bigger than any City of the World, should scape uncontradicted, and 'tis expected that I (if continuing in that Perswasion) should make some Reply to these contradictions.

2. I begin with the Ingenious Author of the *Novelles de la Republique des Lettres*, who saith, that *Reyn Persia* is far bigger than *London*; for that in the 6th. Century of Christianity (I suppose *An. 550.*) It had 15000, or rather 44 thousand *Moschees* or *Mahometan Temples*. To which I reply, that I hope this Objector is but in jest, for that *Mahomet* was not borne till about the Year 570, and had no *Moschees* till about 50 Years after.

3. The next is the excellent *Monsieur Auzout* from *Rome*, who is content, that *London*, *Westminster*, and *Southwark* with the contiguous Housing may have as many People as *Paris* and its Suburbs; and but faintly denyeth, that all the Housing within the Bills, may have almost as many People as *Paris* and *Roven*, but saith that several Parishes inserted

into these Bills, are distant from, and not contiguous with *London*, and that *Grant* so understood it.

4. To which (as his main, if not only Objection) we answer. *1st.* That the *London Bills* appear in *Grants Book* to have been, since the Year 1636, as they now are. 2. that about 50 Years since, 3 or 4 Parishes formerly distant, were joyn'd, by interposed Buildings, to the Bulk of the *City*, and therefore then inserted into the Bills. 3. That since 50 Years the whole Buildings being more than double, have perfected that Union, so as there is no House within the said Bills, from which one may not call to some other House. 4. All this is confirm'd by Authority of the King and City, and so long Custom. 5. That there are but three Parishes under any Colour of this Exception, which are scarce a two and fiftieth part of the whole.

5. Upon sight of *Monsieur Auzout's* large Letter, I made Remarques upon every Paragraph thereof, but suppressing it (because it lookt like a War against one with whome I intended none, whereas in truth it was but a reconciling Explication of some Doubts, and therefore) I have chosen the shorter and sweeter way of answering *Monsieur Auzout*, as followeth, *viz.*

Concerning the Number of People in London, as also in Paris, Roven, and Rome, viz.

M*onsieur Auzout* alleageth an authentick Register, that there are 23223 Houses in *Paris*, wherein do live above 80 thousand Families, and therefore supposing $3\frac{1}{2}$ Families to live in every of the said Houses one with another; the Number of Families will be 81280; and *Monsieur Auzout* also allowing 6 Heads to each Family, the utmost Number of People in *Paris*, according to *Mr. Auzout's* Opinion, will be. 487680.

The

The *Medium* of the *Paris* Burials was allowed by *Monsieur Auzout* to be 19887, and that there dyed 3506 unnecessarily out of *L'Hotel Dieu*, wherefore deducting the said last Number, the neat Standard for Burials at *Paris*, will be 16381, so as the Number of People there, allowing but one to Dye out of 30 (which is more advantageous to *Paris* than *Monsieur Auzouts* Opinion of one to Dye out of 25) the Number of People at *Paris* will be 491430; more than by *Monsieur Auzouts* last mentioned Accompt.

491430.

The *Medium* of the said two *Paris* Accompts is—488055.

The *Medium* of the *London* Burialls is 22212, which Multiplied by 30 (as hath been done for *Paris*) the Number of the people there will be.

696360

The Number of Houses at *London* appears by the Register to be 105315. Whereunto adding a 6th. part or 10531, as the least Number of double Families that can be supposed in *London*, the total of Families will be 115840: and allowing 6 Heads for each Family, as was done for *Paris*, the total of the People at *London* will be.

695076.

The *Medium* of the 2 last *London* Accounts is—695718.

The People of *Paris* according to the above-said Account is } 488055.

Of *Roven* according to *Monsieur Auzouts* utmost Demand, } 80000.

693055.

Of *Rome* according to his own Report thereof. } 125000.

So as there are more People at *London*, than }
at *Paris*, *Roven*, and *Rome* by } 2663.

Memorandum, that the Parishes of *Islington*,
Newington, and *Hackney*, for which only there is
any Colour of Non-contiguity, is not a two
and fiftieth part of what is contained in the Bills } 114284.
of Mortality; and consequently *London* without
them, hath more People than *Paris* and *Roven*
put together, by }

Several other Estimates, Viz.

- I. That *London* alone is equal to *Paris*, *Roven*, and *Rome*, as aforesaid.
- II. That *London*, *Bristol*, and *Dublin* are equal to *Paris*, *Amsterdam*, and *Venice*.
- III. That *London* alone is to *Amsterdam*, *Venice*, and *Roven*, as 7 to 4.
- IV. That *London* and *Bristol* are equal to any four Cities of *France*.
- V. That *Dublin* is probably equal to the second best City, of any Kingdom or State in *Christendome*.
- VI. That *London*, for ought appears, is the greatest City of the World, but manifestly the greatest *Emporium*.

A Description of an Invention, whereby the Divisions of the Barometer may be enlarged in any given proportions; produced before the Royall Society, by Mr. Robert Hook R. S. Soc. and Profess. Geom. Gresham.

Since the discovery of the Alterations, that are in these parts of the World, in the weight of the *Atmosphere*, by the means of the *Torricellian Tube*, there has been several contrivances thought on, to make the more minute variations in the Airs pressure sensible.

And first, the *Wheel-Barometer* was invented and Published by Mr. *Hook*, Anno 1665, in his *Micrography*: (where it is described at large) but this did not answer fully the designed exactness, both for that the Mercury being apt to stick against the sides of the Glass, would rise and fall *per saltum*, all at once, and because it is very difficult to adjust the Ball and Thread and other *apparatus* of this Instrument, as also that it is exceeding apt to be out of order, for which reason it is at present almost wholly laid aside.

Upon this in *June* 1668 (as appears on the Journal of the Royal Society) he bethought himself of an other device to do the same thing, which was to encrease the divisions by putting coloured Spirit of Wine, or some other Liquor not capable of Freezing, on the Mercury, which Liquor was made to rise as the Mercury fell, and fall as it rose, in a narrow Cane, so as to make the utmost limits about two foot asunder. This Invention was afterwards in the Year 1673 Published in *France* by Mr. *Hubin*, who neatly performed the Glass-work; but the Cane being necessarily small and apt to be obstructed with bubbles, (whereby the intercourse of the outward Air would be intercepted) and besides the utmost limits of rise and fall scarce reaching two foot and a half, Mr. *Hook* was not yet satisfied, till he had found out

the

the means of encreasing the Divisions of the *Barometer ad libitum*, by a way free from such Objections, which finally he produced before the R. Society at their meeting on *Feb. 3d. 1685* *st. vet.* The contrivance whereof is this.

Figure I. Tab. II. Represents the Glass of this *Baroscope*: the Cylinder A may be of what Diameter you please, the bigger the better, but it need not be above 2 inches long, the Cane A D must be so long, that the upper part of the Cylinder B may be 29 Inches + such a part of the hight of the other Cane B C, as the weight or specifick Gravity of the Liquor that is to fill that Cane is to the Specifick Gravity of Mercury, below the line *ab* in the Cylinder A. The third Cylinder C may be as high as you please above the Cylinder B, but is most conveniently made, so as the square of the Diameter of the Cane B C be to the square of the Diameter of the Cylinders B or C, (which must be exactly equall) as the rise of the Mercury in the Cylinder B, is to the whole Length of the Cane B C: for in this case there will be nothing Superfluous, but the divisions enlarged to the utmost advantage.

As to the method of filling this *Baroscope*, though the Inventor hath not yet declared his own contrivance for the doing it, yet it will not be unnecessary to shew here how it may be done. One way, (and the best that occurs at present) is to leave a small hole at the top of the Cylinder A, and another near the top of the Cylinder B: this latter being well stoppt, pour in as much Mercury, at the other hole in A, as shall fill both Canes as high as the Level of the said hole; which done, stop either by Hermetically sealing it, or else by a drop of seal-wax (the glass being first ground rough to make it stick) the hole in A; then opening the hole in B, draw off as much of the Mercury of the Cane B C till it will run no longer: which done, stopp firmly the hole in B (which may be done as you please, there being no pressure against you) and you will have the Cylinder A evacuated of Air for your purpose; and the hight of the Mercury will be as is usual in the ordinary plaine and Wheele-*Barometers*.

Then

Then pour into the Cane B C as much Spirit of Wine tinged with *Cochineele*, and Oyle of *Turpentine*, equall parts of each, as shall stand above the surface of the Mercury so many feet as you make the enlarged scale of your Barometer, or as is between the middle of the Cylinders B and C, and you will find the Mercury sink in the Cane B C, and Rise in the other Cane A D, in such proportion, that each 13 foot of Oyle and Spirit, will raise the Mercury ten Inches. This done, you must pour on, by the Cane B C, so much Mercury as may fill up the Cylinders A & B to such heights, considering the present weight of the Atmosphere, that the surface of the Mercury in both, may, at the utmost limits, (which have not in *England* been found to exceed 30, 6 and 28, 6. Inches) always fall within the bodies of the Cylinders, and never enter into the Canes.

Here note that these Liquors are chosen upon two accounts, First they are exceeding near of a weight, and Spirit of Wine highly rectified is somewhat lighter than Oyle of Turpentine, but by a very small addition of Phlegme or Water, the Spirit will præponderate and be undermost; so that you may make them as near of a weight as you please, and consequently a Cylinder of the Oyle insensibly differing from an equal Cylinder of Spirit of Wine. Secondly they are Liquors that will not mix; so that the Oyle of Turpentine swimming on the top, will be divided by a line only from the tinged Spirit of Wine, which the Oyle will keep from Evaporating.

The effect of this Baroscope will be, that when the Atmosphere is heavy, and the Mercury raised high in the Cylinder A, and retired out of B, the Spirit of Wine will descend into the Cylinder B, and the Oyle of Turpentine will fill the Cane, so as to make the partition of the two Liquors near the Cylinder B. But on the contrary when the Air is light, the Mercury will sink in A and rise in B, so as to drive the Spirit of Wine into the Cane, and the Oyle of Turpentine into the Cylinder C, so that the section of the 2 Liquors will be near C, and the Variation of the height of the Mercury will be enlarged.

larged into almost the length of the Cane, without that the Counter-pressure from the Liquors will be in the least altered, the hight and weight of the Incumbent Cylinders being always the same.

That little alteration that may happen by the dilatation and contraction of the Spirit of Wine by heat and cold, which ought to be accounted for, may be best discovered by a Thermometer hanging by it (containing the same quantity of Spirit of Wine, and whose Cane is, as near as may be, of the same Diameter with the Cane BC in the Barometer) whose descent and ascent must be added and substracted to reduce it to a rigorous exactness; but it is still worth while to enquire if the Mercury it self do not shrink and swell with cold and heat, so as not to need this correction.

Thus is a remedy found out for the defects and inconveniences of the Barometers hitherto produced, and an Instrument discovered, which like a new Sence, will most nicely shew those alterations in the Air, which without it would by no means be perceptible, and of which undoubtedly very great uses might be made in order towards a perfect *Meteorologie*, which, without some such help as this, can hardly arrive at any great point of certainty.

But I forbear to say more about it, least (by omission of some material circumstance) I should prejudice the Ingenious Author of this discovery, who has promised to publish a more particular account thereof; what is here said being only intended to assert the Right of the first Invention of this Useful and Subtile Instrument to its proper Author, from the pretensions of all others.

Accounts of Books. (1.) Le grand & fameux Probleme de la Quadrature du Cercle resolu Geometriquement par le Cercle & la Ligne droite, par Monsieur Mallement de Messange. A Paris, in 12° 1686. With a Refutation of the same, by Mr. D. Cluverius. Reg. S. Soc.

THIS Author is one of those unhappy Geometricians, who without having acquired a through Understanding of the Principles, have yet thought themselves able to master the abstrusest Difficulties in this nice Mathematical Science, where the least oversight or mistake subverts the whole superstructure. Hence it is, that the true Quadrature of the Circle here pretended to, is lost upon the same Rock with those many others, which the less knowing and more opinionated of their own Skill have produced, in this and the last Century: But briefly to shew wherein the Paralogism of our Author consists, we must first lay down the construction, whereby he pretends to do the Business: In Tab. 2. Fig. 2. let $f k z k$ be a Circle, $f a z$ the Diameter, a the Center, $k z k$ an equilateral Triangle inscribed, $B b$ a line equal to the three sides of that Triangle, and dividing the Arch $f k$ equally in i , the line $i e$ will be half the side of a Hexagon inscribed, which side taken 6 times, is the line $e E$ = to the circumference of the Hexagon; and dividing the Arch $i f$ in b , the line $b d$ is half the side of the Dodecagon inscribed, and $D d = 24 b d$ is the circumference of the Dodecagon; and proceeding after the same manner, the circumferences of Polygons of 24, 48, 96 sides, &c. may be found, approaching still nearer and nearer to the circumference of the Circle, which at length will be equal to the line $f F$ in the Tangent; but how to find the Point F is all the Skill: Here our Author tells us, that the Points $B E D F$ are all in the Arch of a Circle, whose center is in the line

H h f z

fz continued; but to contract his Work into a little compass, he assures us that it is all one, if instead of the whole circumferences Bb , Ee , Dd , Ff he take the lines bq , ep , do , fm , each a third part of its correspondent, and that in this case too, the Circle whose Center is L , taken in the Diameter fz continued, shall pass through the Points o , p , q and intersect the Tangent Ff in the Point m , so as to leave $fm =$ to a third of the circumference of the Circle; which supposition being proved to be groundless and erroneous, all the consequences drawn from thence must be so too. If our Author had but considered what the intermediate Points of the Curve between o & p , p & q , q & t ought to express, he could not but have discovered the fallacy himself, for the lines od , pe , qb are each proportioned to fm , as the sines kb , ie , hd to their respective Arches kf , if , bf , and so of all the rest between o and m . This would have taught him, that the Curve he has occasion to use, did universally express the Proportion of the Arches to their Sines, by that of the line fm to its respective ordinates; that it was a sort of *Linea Quadratrix*, to be reckoned among the *Linea Geometricae Irrationales*, or such whose relation between the parts of the Diameter and the Ordinates, are not generally expressible by any one Equation; that this Curve did intersect the Circle in the middle of the Arch kx , and contingit it in the point z . This Curve will be better understood in Fig. 3, where it is drawn as it ought, and wherein the proportion of the line fm to the lines qb , is as any Arch kf is to its Sine kb .

'Tis evident, that this Curve is not the Circle $mopqt$ in Fig. 2, yet 'tis not apparent but that a Circle passing through the point m , may intersect it in several points, as o, p, q : (but to suppose it to pass through all the extremities of the Circumferences of the infinite Polygons between the Circle and Triangle, or their thirds, is to make it coincident with that Curve.) It remains therefore to shew, that the Circle passing through p and q , whose center is in the Line fz , does not pass

pass through the point *o*, which from the following Considerations will be made evident.

First let it be required, by the extremities of the lines *a, b, c*, or *b, g, f* (in *Fig. 4*) parallel one to another and *d, e*, or *k, l*, given as parts or segments of the Axis or Diameter of the Figure, to determine what curvity passeth through their extremities, according to the conditions of the five Conical Sections.

First if it be found that $\frac{bb - aa}{de} - \frac{cc + aa}{de + ee}$ is equal to 1 =

$\frac{cc - aa}{dd + ee} - \frac{cc + bb}{ed}$, then it is the Characteristic of a Circle, the Lines *a, b, c* being disposed in an uniform increasing order :

But if *c* the biggest stands in the middle, than $\frac{cc - aa}{dd + ee} +$

$\frac{cc - bb}{ee + de} = 1 = \frac{cc - bb}{de} + \frac{bb - aa}{de + dd}$ will shew the same. If the

Lines *d, e* be segments of a line drawn parallel to the Axis, then transposing and ordering the foregoing Equations, Rules

also may be found accordingly. If $\frac{c - b}{b - a} = \frac{e}{d}$, or $\frac{c - a}{b - a} = \frac{e}{d}$ = 1, then the Line passing through the Extremities is right :

If $\frac{cc - bb}{bb - aa} = \frac{e}{d}$, then a Parabola is designed. The Characteristick of an Hyperbola or Ellipsis differs not from that of a Circle, but only by a Relation to the inequality of the Axes, and the alteration of the Signs + and -.

Secondly, out of *a, b, d*, or *b, c, e*, lines given, that stand in the Arch of a Circle, to find the Distance from the Center = to *m*, or *m + e*, and to determine the Radius. There is a little variety in the case, when the given lines are in the same Quadrant or otherwise: but there being only occasion for this

first Case, the Rule is this, $\frac{cc - bb}{2e} + \frac{1}{2}e = e + m$: And

$$\sqrt{\frac{cccc - 2ccbb + bbbb}{4ee}} + \frac{1}{4}ee + \frac{1}{2}bb + \frac{1}{2}cc = \text{Radius}.$$

Thirdly, in a Circle, having *a, b, d* and *e*, to find *c*: The
H h 2 Equa-

Equation is $\frac{b^2 e - a^2 e}{d} - d e - e^2 + b^2 = c^2$. Fourthly: To inscribe

Polygons in a continual double Progression within a Circle, many different Rules may be given: the following will serve, which is the same with that, how to find the subtense of an Arch, out of the subtense of a double Arch. The Rule is thus; $2 R^2 - \sqrt{4 R^4 - A^2 R^2} = B^2$; Supposing A to be the Chord of a double Arch, and B of a single Arch. From hence it is easily deduced, that $\sqrt{3} R^2$ being the side of an equilateral Triangle inscribed, the side of a Hexagon will be R: of the Dodecagon $\sqrt{\frac{1}{2}} R^2 - \sqrt{\frac{1}{2}} R^2$: and so for the rest. Now reducing according to these Equations the Lines to Numbers, it will be found that in *Fig. 2 Tab. 2*

$$\begin{array}{ll} b q = 173205,08 & a b = 50000,00 \\ e p = 200000,00 & e b = 36602,54 \quad f m = 209439,51 \\ d o = 207055,23 & d e = 9990,04 \end{array}$$

But supposing, as our Authour will have it, that *d o* stands in the same Circle with *b q* and *e p*, it follows that the Square of *d o* = 422638679 &c. whereas it should have been equall to 428718707 &c. Square of *d o* in the Table. The Square of the Tangent *f m* is also a great deal to small, and the whole Quadrature to little: All which make it appear, that the Glory of *Lewis* the Great is not (as this Book pretends) much advanced by the Atchivements of this Author; who would have done well, in a Matter that so little needed it, to have forborn to make use of the sacred Words of our Saviour, *Math. 11th. 25th.*

II Voiage de Siam des Peres Jesuites envoyez par le
Roy aux Indes & a la Chine. A Paris 1686. 4°.

THis is a second Relation of the Voiage and Embassy of the *French* to the King of *Siam* in the Year 1685, and being a more particular Account than the former, an extract of this, 'twas thought, might suffice for both: That was composed by *le Chevalier Chaumont* the Embassadour, and now this by *le Pere Tachart* Jesuite, who was one of six Fathers of his Order, that went with the Embassadour, as Missionaries to *China*. The whole being much interspersed with matters of Religion and Ceremony, I shall only take notice of such things as relate to Arts and Sciences, and particularly of the Astronomical Observations made at the *Cape of Good Hope* and at *Siam*; whereby the Longitudes of those places are stated: following herein the Authors method.

He divides his Treatise into six Books, whereof the first contains the Voiage from *Brest* to the *Cape of Good-Hope*. Here he gives the reasons and motives of sending this Embassie, as likewise the six Jesuites who are Mathematicians and by the Kings Letters Patents are so stiled; Their Instructions being, besides their Spiritual Function, to prosecute the business of the *Royal Academie of Paris* (of which they are admitted Members) by accurately observing the curious things in Art and Nature, and particularly to make Observations for discovering the *Longitudes* of the Places where they pass; for which purpose they are well provided with Instruments. They sailed from *Brest* on the third of *March st. n.* and arrived at the *Cape of Good Hope* the last day of *May*, taking notice by the way of the several remarkables in that Voiage, which are here too well known to need repeating; But mentioning the faultiness and rectification of the Southern Constellations, our Author is not willing to take notice of what has been done in that matter by a member of

of the *Royal Society* of *London*, tho' his Catalogue of those Starrs hath been translated from *Latine* into *French* and Printed at *Paris*, and an Account thereof is in the *Journal des Scavans* of Aug. 7. & Sep. 4. 1679; but speaks of it as a thing not done, wishing they had had the opportunity to augment the Science of *Astronomy*, by observing them themselves.

The second Book is entituled the Voiage from the Cape of Good Hope to the Iland Java; but is chiefly taken up with the description of the Colonie of the *Hollanders* there, the Natives, and the *Astronomical* Observations they made there during their stay, by which they have determined the Longitude of the Cape of Good Hope 18 degrees to the East of *Paris*: (but here we must begg leave to make a Remark) He mentions 7 several Nations of the Natives, viz. the *Hottentots*, whom he describes at larg, the *Namaquaas*, (of these two there are the Figures) the *Ubiquaas*, the *Gouriquaas*, *Ila-siquaas*, *Sousiquaas* and the *Odiquaas*: and here he relates a Voiage made in the Year 1685, as farr as the *Tropick*, by the Governour of the Cape, Mr. *Vanderstell*; who is said to have found about the Latitude of 27 degrees and about 10 or 12 leagues from the shore, a Nation of Natives that are very Musical, who have long Hair flowing on their shoulders, some of the Men as White as *Europeans*, and their Women Naturally very White, but they Blacken themselves to please their Husbands: This Nation seems to have much more Intelligence than their Neighbours, but some circumstances seem to argue it Fabulous.

Here are likewise the Figures of a Stag with Horns like a Goat, of the *Zembra*, the *Sea Com*, the *Cerastes* or Horned Serpent, the *Camelion*, and two sorts of uncommon Lizards, whereof one is made to have 3 fair Crosses on his back: Speaking of *Elephants* he says he was told by creditable persons, that they had seen the foot steps of *Elephants* two foot and half diameter; and that there are *Rhinocerotes* there as bigg as ordinary *Elephants*, but, by I know not what mistake, he makes the *Rhinocerote* a two horned Animal. The Voi-

age from the *Cape* to *Java* (in sight whereof they arrived *Aug. 5th. st. n.*) contains nothing very Extraordinary.

The third Book is the *Voiage* from *Java* to the Kingdome of *Siam*: which is chiefly taken up with what occurred at *Bantam* and *Batavia*, and at their arrival on the Coast of *Siam*, here are represented the Roads of *Bantam* and *Batavia*, together with the Plan of the City and Fortrefs of *Batavia*.

The fourth Book describes the Entry and Audience of the *French* Embassadour at the Court of *Siam*, who, as they say, was received with more Honour and Respect, than was ever yet shewn to any Ambassadour whatever; and that even those of *Persia*, the *Mogul* and the *Tartar* Emperour of *China*, (tho' his neighbour, and by much the most Potent Monarch of the Universe) present themselves before the King of *Siam* on their Knees, whereas Mr. *Chaumont* the *French* Ambassadour made his harangue, sitting with his Hat on his Head. Here are described the *Baloons* or *Barges* of State which are used at *Siam*, which are of a very odd Figure, as of *Serpents* or *Sea-Horses*, but which by their sharpness and number of Oars are of an incredible Swiftnes: here likewise 'tis related that the old *White Elephant* of the King of *Siam* is near upon 300 Years Old; as also that there are *Tumblers* there, of an extraordinary Agility, as that they would stand upon one Foot on the top of a *Bamboo* of 80 or 100 Foot high, and then turn themselves, and stand on their Heads thereon, and afterwards hang, by the Chin only, on the top of the same, and then descend by a Ladder down right, with an incredible Swiftnes, working their Bodies all the while through the Rounds of the Ladder.

The fifth Book is entituled the Return of the *Voiage* of *Siam*, and first relates several notable Shews presented to entertain the Ambassadour; as the fight of two *Elephants*, who were only suffered to twist each others Teeth, as Bulls do their Horns; the fight of an *Elephant* and a *Tiger* or rather a *Panther*, according to the description; and the manner of catching the wild

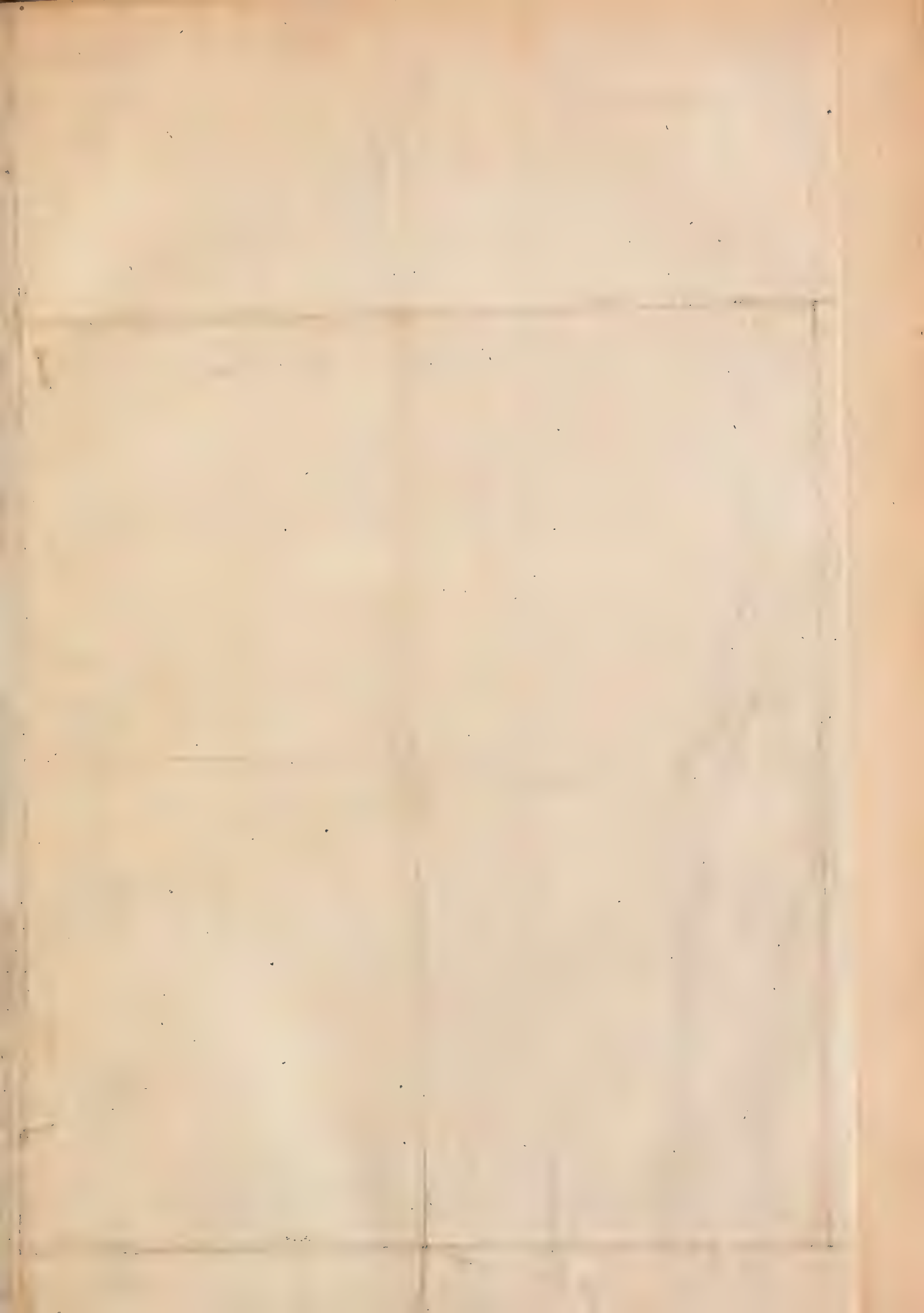
wild *Elephants*, by alluring them into an inclosure by the means of a Female tame *Elephant*, and the like. Next are related several Observations of the variation of the Magnetical Needle, which was found towards the end of the Year 1685, to be about half a degree West, at *Louvo* near *Siam*; as likewise the Observation of an Eclipse of the Moon on the 10th. December. *st. n. post mediam noctem*, made at a place near *Louvo* called *Thlee-Poussonne*, in the presence of the King. It begun about 15h. 20m. the Total Darknes at 16h. 23m. 45s. the Emerfion or end of Total Darknes at 18h. 2m. 36s. or rather, as is there said, at 18h. 10m. 25s. whereby the Longitude of this place is found 98 degrees and half from *Paris*, and about 6h. 45m. to the East of *London*, as may be seen by comparing this Observation with the Observations thereof made at *Dantzick*, *Nurenburg* and *Lisbon*, Published in *Philos. Transact.* Num. 178, 182 and 184. And whereas tis here said that some Charts have made the Longitude of *Siam* above 20 degrees more than it is, tis to be understood only of the Charts of *Sanfon*, which in this particular are the worst extant: But that this Correction is just, we are fully satisfied, by the like errors in those parts, discovered and published in the *Philosoph. Collect.* of Feb. 168 $\frac{1}{2}$, and in *Philos. Trans.* of June 1683. The relation of the homeward bound Voiage (which was of about 6 Months) is short and contains very few considerable Remarks.

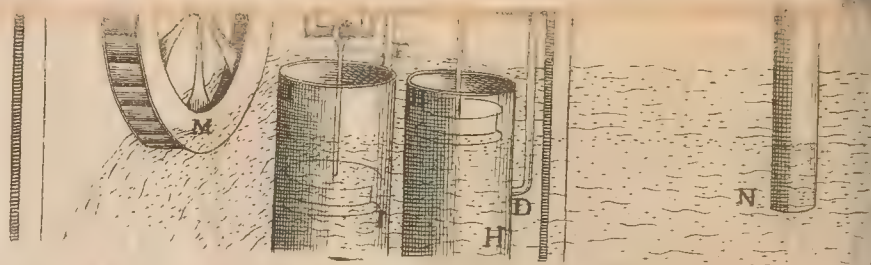
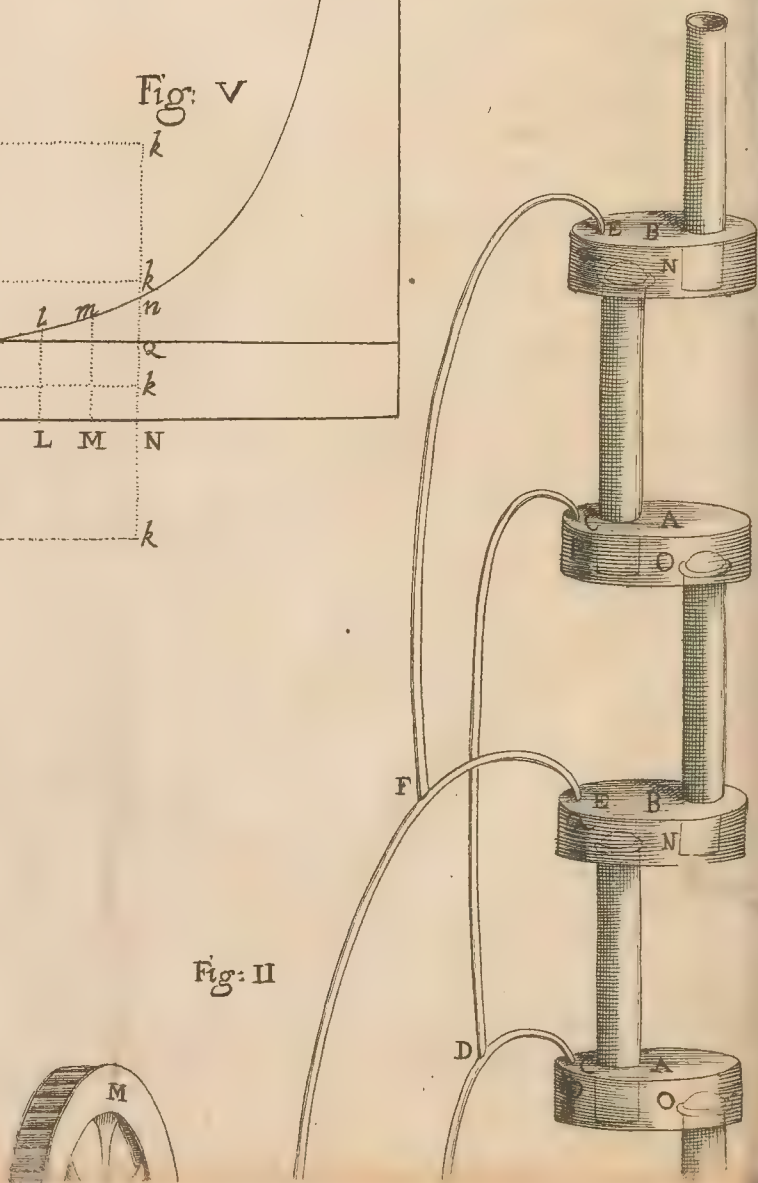
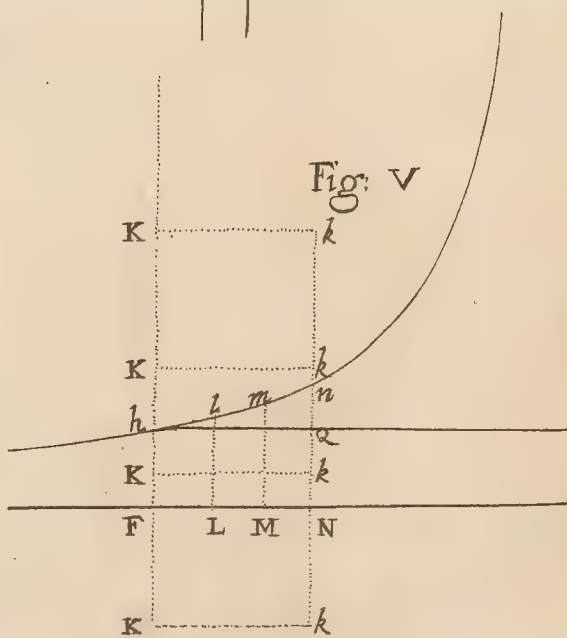
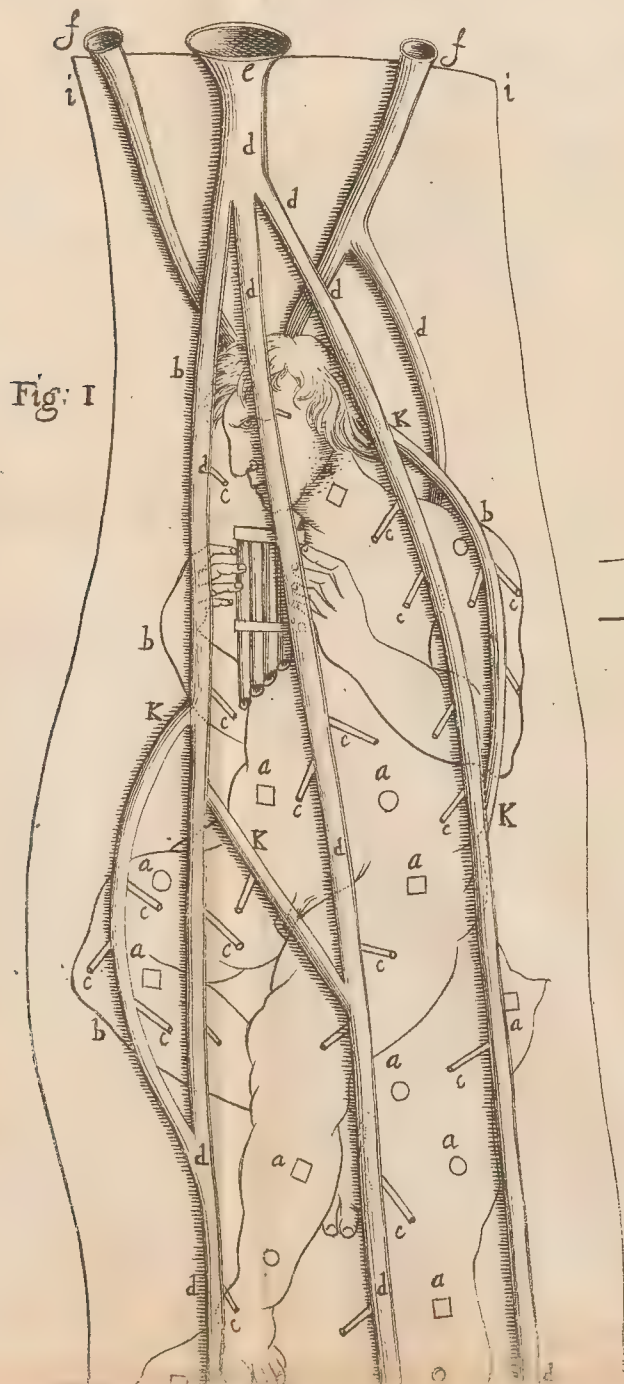
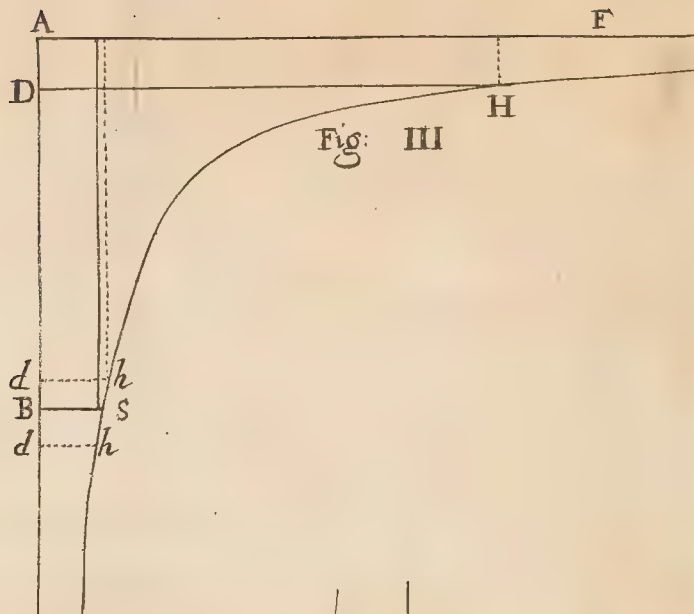
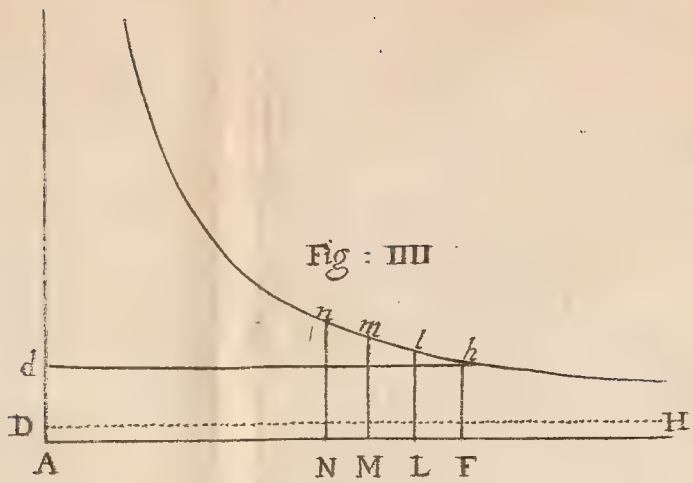
The sixth and last Book is of the manners and Religion of the *Siammers*, where is a short description of the Kingdome and Capital City of *Siam*: Next the habits of the People, and their use of *Betele*, *Arek*, and *Tea* is described, as likewise the Root *Ginseng* so much esteemed in the East, with its Vertues and Uses. As to the Religion of this people, which is here described at large, I shall say little to it, as not falling under our Argument, only one principal point therein is the *Metempsychosis* of *Pythagoras* and the *Bramines*, and they hold the Eternity of the World, but on the contrary they suppose God Mortal, Corporeal and produced in time: heir present God they call *Sommonokhodom*.

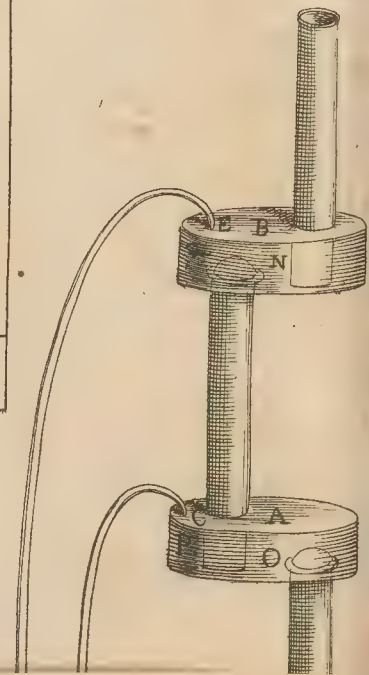
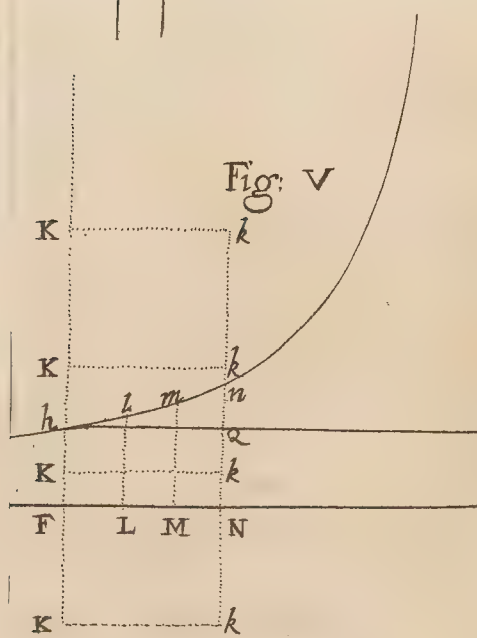
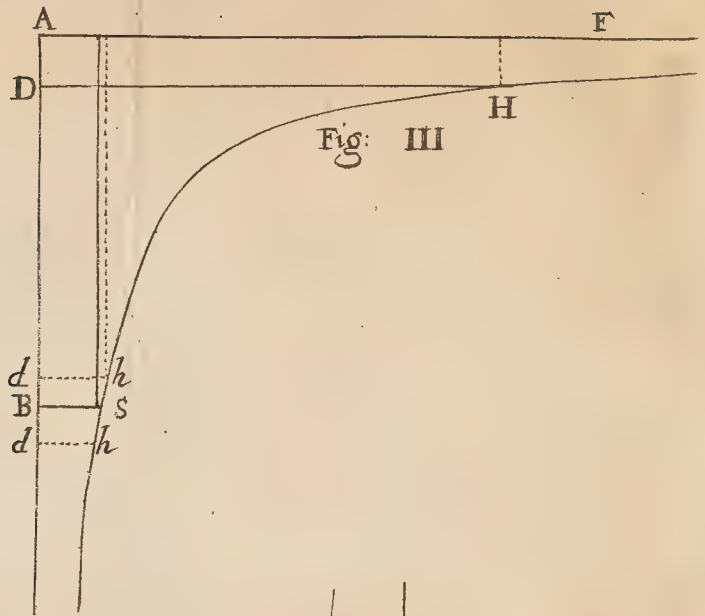
A Remark concerning the Longitude of the Cape of Good Hope.

IN the second Book of this Voyage are related two Observations of the *Satellites of Jupiter*, capable, if well made, to ascertain the Longitude of the *Cape of Good Hope*. The first was there made *June 2d. st. n. 1685*, when at *11h. 29m. 20s.* the first or innermost *Satellite* touched the *Western* edge of *Jupiter* and at *11h. 30m. 50s.* it appeared no more: this Observation is said to be made with an excellent *Telescope* of twelve Foot: The other was on *June 4th. following. st. n.* when the *Emersion* of the same *Satellite* was observed at *9h. 37m. 40s.* from which latter is concluded, that the Longitude of the *Cape* is *18 gr.* to the East of *Paris*, for that the said *Emersion*, according to the *Calculus* of *Sigr. Cassini*, in the Meridian of *Paris* ought to have happen'd at *8h. 26m.* This same *Emersion* is computed by *Mr. Flamsteed* at *8h. 19m.* at *London*, that is, *3 m.* later than by *Sigr. Cassini*; and considering that neither is verified by Observation in *Europe*, the Longitude hence deduced is doubtful at least *3 minutes*, if this had been the only Observation: But the former being considered will yet shew that there is a much greater Doubt still remaining: For from certain *Astronomical* Principles the *Parallax of the Orb*, or Difference between the Place of *Jupiter* seen from the *Sun* and *Earth* was, at the Time of the first Observation, *9gr. 19m.* which Arch that *Satellite* moves in *1h. 6m.* and the utmost Duration of an Eclipse thereof in this Position of *Jupiter* being scarce *2h. 20m.* (as appears by the accurate Observations of *Mr. Cassini* and *Mr. Flamsteed*) it will follow, that from the Immersion behind *Jupiters* Western Edg, to the Emersion out of the Shaddow, there could not be full *3h. 26m.* wherefore the Emersion out of the Shaddow, on *June 2d.* ought, according to the Time of the Immersion, to be at *14h. 56m.* at latest, at the *Cape*; which by *Mr. Flamsteeds Calculus* was at *London 13h. 51m.* or according to *Sigr. Cassini* at

13^h. 58^m. at *Paris*. Hence the Longitude of the *Cape* will be found but 14 *Degrees* and half at most to the East of *Paris*; so that these 2 Observations will differ in the Result about a quarter of an Hour; which is a little too much. However there are some Reasons that seem to argue for this latter Longitude rather than the former; for it is much easier to observe what becomes of a luminous Object that appears, than to wait upon the first Appearance of a Star Eclipsed: and tis probable that the *Satellite* might, in the latter Time, be several Minutes Emerged out of the Shaddow, when they might first perceive it; but they could not but see the Application to the Body of *Jupiter* in the former, if we may suppose their *Telescopes* so good as they are said to be: And that the *Cape of Good Hope* is not more than an Hour to the East of *Paris*, is proved by the constant Consent of our Navigators, who find by their Reckonings that the Island of *St. Helena* is about 22 or 23 *Degrees* of Longitude to the Westward of the *Cape*; (and that Sailing both backward and forwards tis the same, which takes away the Objection of Currents) now by accurate Observations made at *St. Helena*, and compared with others made in *Europe* at the same Time, the Longitude of that Isle is certainly about $8\frac{1}{2}$ *Degrees* to the West of *Paris*: It follows therefore that the *Cape* cannot be much more than 14 or 15 *Degrees* to the East of *Paris*; and undoubtedly it must be less than 18, for 3 *Degrees* is much too great an Errour to be committed in so short a Distance Sailing.







PHILOSOPHICAL

TRANSACTIONS

For the Months of *January, February and March, 1687.*

The CONTENTS.

1. **A** *N account of a Comet seen at Lipsick in September 1686. taken from the Lipsick Acta Eruditorum for the Month of November last: (2) Part of a Letter written to the Revd. Thomas Gale, S. T. D. Reg. Soc. Secr. from Carniola, by Mr. John Weichard Valvasor liber Baro, containing the Method of Casting Statues in Metal; together with an Invention of his for making such Statues of an extraordinary thinness, beyond anything hitherto known or practised. (3) The Answer of Dr. Papin to several Objections made by Mr. Nuis against his Engine for raising Water by the Rarefaction of the Air; whereof a description is given in Numb. 178. of these Transactions. (4) An Answer of the same to the Author of the Perpetual Motion. (5) Occultatio Saturni a Luna plena, Anno 1687. Martii 19no. mane: observata a D. Ed. Haines R. S. S. ad Totteridg prope Londinum, sub Lat. 51 gr. 39m. (6) A Discourse concerning the measure of the Airs Resistance to Bodies moved in it: By the Reverend John Wallis S. T. D. and R. Soc. Soc. (7) Part of a Letter from Mr. William Cole of Bristol to the Publisher, about the Grains resembling Wheat, which fell lately in Wiltshire. (8) An Extract of a Letter written by Mr. Veay Physitian at Tholouse, to Mr. de St. Uffans, concerning a very extraordinary Hermaphrodite in that City. Communicated by Dr. Aglionby. R. S. Soc. Accounts of Books. I.*

I. *Historia Plantarum, species hætenus editas aliasque insuper multas noviter inventas & descriptas complectens, &c. Autore Joanne Rajo e Societate Regia. Tomus primus. Londini, 1686. Fol. Apud Henricum Faithorne R. S. Typographum; ad Insigne Rosæ in Cæmeterio D. Pauli.*

II. *Philosophiæ Naturalis Principia Mathematica, Autore Is. Newton, Trin. Coll. Cantab. Soc. Matheseos Professore Lucasiano & Societatis Regaliæ Sodali. Londini. 4to. Prostat apud plures Bibliopolas.*

*An Account of a Comet seen at Lipsick, Sept. 1686.
taken from the Lipsick Acta Eruditorum for the
Month of November last.*

THAT Comets are so frequently seen of late above what has been formerly observed, happens rather from the diligence and number of those that now apply themselves to the study of the Cœlestial Motions, than from any casual concurrence of those Bodies. That this is so, may be concluded from the five Comets, that in less than six years time have been seen to traverse the Heavens, of which yet only the two first (*viz.* those of 1681 and 1682) by reason of their long tails were generally regarded. That that appeared in *July* and *August* 1683. was not, as I can hear, any where observed in *France*. That that appeared in *June* 1684 was no where else taken notice of but at *Rome*: and now this of *September* 1686. we have no other account of, than this from *Lipsick*. The truth is, that where Comets are destitute of a tayle and appear only like an obscure hazie Star, as those of 1683 and 1684 did, they that first discover them had need be well acquainted

acquainted with the Constellations (which few People are,) and must look over the Heavens designedly with great attention, notwithstanding all which 'tis possible for such obscure Stars to pass by unseen.

This Comet was observed at *Lipsick* by the diligent and accurate Mr. *Kirck*; in whose Ephemerides for this year there is likewise a brief account thereof; He saw it only twice, viz. on the 8th. and 9th. of *September* st. vet. 1686. and observed it as follows.

Sept. 8. 4h mane about day-break, he found the Comet in the Constellation of *Leo*, to the right hand of the *Lucida in Lumbis* α (as is conceived, for the Latin Copy is defective in this place) and resembling that Star in colour and magnitude, with a thin and short taile extended upright. Over the Comet in the same verticall was the Star θ α of *Bayer*, or 21 *Tychoni*, distant therefrom by the Micrometer, exactly a degree; and a Line drawn from the *Lucida in lumbis* α to the Comet passed much about half a degree to the right hand of the said θ *Leonis*. The distance of the Comet from *Regulus* taken by a *Radius* was about 17 gr. The next Morning, *Sept. 9.* the Comet appeared again obscurer and more difficult to observe than before, by reason of the day-light: however, at 3h 58m the distance thereof from θ α was found by the Micrometer $2^{\circ} 23\frac{1}{2}m$. and at 4h 40m. again 2 gr. $25\frac{1}{4}m$. To verifie the Times, the Altitude of the *Lucida in Lumbis* α was Observed 11 gr. 10min. at 4h. 08m. mane. A right Line drawn by the Comet and the said θ *Leonis* towards β *Leonis*, or the *Lucida Colli*, left that Star a little to the right hand. The following days being Cloudy no more could be Observed.

This Comet was seen by a Countryman, who first gave notice thereof, from the 6t to the 12th of *September*; the result of whose Observations is, that the Comet was direct in motion, that it moved about $1\frac{1}{2}$ degree *per diem*, and that it seemed rather to decrease in Latitude. On the 7th
of

of *Septemb.* it was about 24 *min.* distant from θ *Leonis*, but its bearing therefrom is not set down. From other parts it is said to have been seen from the first of *September*, but nothing observed.

N. B. That this Star θ *Leonis* was then in 9 *gr.* 2 *min.* of π with North Latitude 9 *gr.* 41 $\frac{1}{2}$ *min.* Whence at the time of the first Observation it may be concluded that the Comet was in 9 *gr.* 55 of π with North Latitude 9° 15 *min.* And at the second Observation the Longitude of the Comet will be found about 11 *gr.* 20 *min.* in π , with much the same North Latitude as before.

These Observations being so few, do scarce suffice to conclude any thing concerning the preceding or consequent motions of this Comet, which being near the Sun and still approaching him was soon lost in his Beams. It may however serve one day, when the Theory of Comets shall attain its perfection, to confirm an *Hypothesis*, and help to ascertain the number of these Heterogeneous Planets, whose frequency makes it more than probable that they have their periodical returns, tho hitherto unknown. And that the Prophecy of *Seneca* [*Erit qui demonstret aliquando in quibus Cometæ partibus errent; cur tam seducti a reliquis, quot qualesque sint,*] is not wholly to be despaired of, will soon appear, from the accurate Theory of the Comet of 168 $\frac{2}{7}$, to be found in the incomparable Treatise of *M. Isaac Newton*, an account whereof is given at the end of this *Transaction*.

Part of a Letter written in Latin to Thomas Gale, S. T. D. Secret. Reg. Soc. from Carniola, by Mr. John Weichard Valvasor liber Baro; containing the Method of casting Statues in Metal; together with an Invention of his for making such cast Statues of an extraordinary thinness, beyond any thing hitherto known or practised.

I Send you likewise my Method of casting Statues in Metal, in obedience to the Commands of the Royal Society; it is as follows. *First*, I form out of good Clay, that will endure the Fire, and not crack either in drying or burning, such a Figure or Statue as I desire to cast; when this is well dry, I make, all over the Figure, little holes of no great depth (but both size and depth proportionate to the bigness of the Statue) into which I let small pieces of Metal, and with some of the same Clay fix them firmly in the holes; the use of these bitts of Metal, marked in Figure. I. *a, a, a, a, a,* is to keep the *Core* and *Mould* from touching one the other, or falling together when the Wax runs out; and that they may remain constantly in the same fixt Posture. This done, I scrape away with some proper Instrument as much of the Clay in thickness as I design for the thickness of my Statue, and then laying it in a Furnace, I burn the *Core* till it be red-hot. (by the *Core* I mean always the Statue first made in Clay.) When it is cold I rub the *Core* all over with that sort of Earth or colour, which our *German* Potters use, to colour the joynts of the Tiles when they sett Stoves of Tiles or (*Kachel-Ofens*;) This Colour resembles much that which the French call *Plomb-de-mer* (*Black Lead*)

Kk which

which is used to design on Paper, and easily wipes out with Bread, but it is not the same: this colour I mix with Water, and daub all over the *Core*, because the Metal is found to run freely upon it. There are other Substances proper for this purpose, but I have always made use of this, especially for thin Statues. This done, I lay on upon the *Core* as much yellow Wax mixed with Pitch or Rosin as will make the thickness of the intended Statue, which I form in the Wax with all the exactness possible.

Here note, that the Particles of Metal mentioned to be set into the *Core*, to keep it at a distance from the *Mold* must be so set as to fall in with the surface of the Wax exactly: and that the reason of mixing Pitch or Rosin with the Wax is, because that when it is burnt out, it makes a great smoak, and that smoak adhering to the *Mold* occasions the Metal to run more freely: as I have experienced it. Next I put all over upon the surface of this Statue of Wax, little pieces of Wax which I call the little chanel; in the Figure marked *c. c. c. c. c. c.* (all which must be contrived so as to enter into the great Channels *d. d. d.*) This done, I cover the *Core* and wax all over with the same sort of Clay, that will endure the Fire without cracking; and so I have my Concave Statue or Mould made. Upon this I lay the great Channels marked *d. d. d. d.* both upright and transverse, formed likewise in Wax, and placed according to Judgment, so as best to receive the ends of the little Channels *c. c. c. c. c.* for the more easie distribution of the Metal. These great Channels must all meet at the top of the Statue, so as to come out by one hole, as at *E*, where the Metal is to be poured in; it is also necessary to have a Chanel or two to let out the Air as the Metal enters, as those marked *f. f.*: and there must be a hole or two left at the foot, as *g. g.*, where the great Channels and waxen Statue joyn; and whereat, when the Mould is burnt, the wax as well of the Statue as of the Channels may run out. The great Chausels being thus placed, the Mould must

must be again laid over with the same sort of Clay. (I use constantly to bind about the Mould with Iron Wire and then lay on more Clay) and when this Mould is well drie, then I heat it red hot ; as I did before the Core, so now both together.

The first time I practiced this method, I burnt both Core and Mould together, and all the small bitts of Metal melted, so that, though it chanced to succeed well, yet I was in great danger of miscarriage ; and ever since I burn the Core first, that so there may not need so strong a fire to burn the *Mould* : but for small manageable Statues of not above a foot or two high, they may be both burnt together, and there is no need of the holes *g. g.* but the *Mould* may be inverted, and the Wax run out by the Channels *f. f.* and *E.*

The *Mould* being thus burnt, I stop with the same Clay the two holes *g. g.* and then I bury it in a pit, and proceed as is usual in casting of Bells and the like, but care must be taken that the Metal be very well in fusion.

If it be a small Statue not above a foot or two high, whose *Mould* may be managed in ones hands; then I make me a concave Statue of Wax, of the thickness I desire, and then place upon it all those great and lesser Channels, as afore : which done I put it all together, into a liquid substance made of Plaister and Tile or Brick dust tempred with water ; but I doubt not but the way of casting in Plaister is well known in *London*, and therefore shall not need to write it.

If the Statue be intended very thin, then I take Copper, and when it is well in fusion, I mix with it a good quantity of *Zinc*, without observing any certain proportion of weight ; the more *Zinc* the better the Metal runs. I have sometimes for small and thin Statues put in above a third part of *Zinc*. now *Zinc* is a certain Mineral Substance like *Marcasite* or *Bismuth*, in French *du Zinc* ; without it our work would not succeed if it be very thin, and

I have found by experience that this Mineral makes the Metal run most freely, and gives it a fair golden Colour.

The Statue being cast, I take off the *Mould* and cut off all the little Channells ; all which both great and small are filled with Metal, which may be kept for further use : In these there is much more Metal than in the whole Statue ; for if the Statue be very thin, there must be more and bigger Channels ; and so the cheaper the the Statue the more weighty the Channels and the more Metal remaining.

To know the quantity of Metal requisite for my intended work, I take a lump of the same mixture of Wax and Pitch, with which I make the *Mould* of my Statue ; and having weighed it, I make a *Mould* upon it, and cast in the same a lump of Mettle of the same size ; which I weigh and thereby compute the proportion of the weight of the Mettle and Wax ; then observing how many pounds of Wax I use about the Figure and Channells, I can calculate to a small matter how much Metal I need to melt.

This is my manner of casting statues very thin, and which always succeeded happily with me. Hitherto I have cast no statue above nine foot high, but I doubt not but I could, by the same methods, cast one of any bigness desired. And when we shall be more at ease from our ill neighbour the *Turk*, I will cast at one fusion the Statue of our Emperour *Leopold. I.* setting on Horsback, much greater than the life ; I have been already in treaty about the charges thereof with the States of this Country ; and if these *Turkish* troubles had not come upon us, it had been now finished. &c.

The Answer of Dr. Papin to several Objections made by Mr. Nuis against his Engine for raising Water by the rarefaction of the Air, whereof a description is given in No. 178. of these Transactions.

Having seen in the *Nouvelles de la Republ. des Lettres* of the Month of *December* last, some difficulties which Mr. *Nuis* doth find in my new way for raising Water, published in the *Philosophical Transactions* of the month of *January*; I am obliged to answer them as clearly as I can in these short notes.

In his first Objection he saith, that it would be a very hard matter to hinder but some Receptacles would come to be fill'd too much: So that the water filling also the pipes C D D would hinder the effect of the Engin. To this I answer that it being necessary to let out the water of the highest Receptacle, I thought it might be conceived that the water may also be let out of the inferiour Receptacles by inserting into each of them a crooked pipe, reaching a pretty way downwards, and having its lower aperture shut up with a valve; whereby the water might run out when the Receptacle should be fill'd to a certain height: and so I did not Iudge it needfull to prevent this Objection.

The second Difficulty, which I had very well foreseen (as it is plain in my first explication) lyes in the great quantity of Air to be rarefied: So that Mr. *Nuis*, by his computation, doth find that the Pump's should every one contain, 84 cubick feet of rarefied Air to raise water at 12000 foot distance. To this I may answer, first that I have not positively promised a good success but for *Windsor* and *St. Germain*; but when I spoke of *Versailles* I used the word *perhaps*, thereby shewing that before any one should go about such a great undertaking he should reflect vpon it

it more than I would then do, not having occasion for such work: but since I have seen Mr. *Nuis* his Objection, I have been Obliged in order to answer him to make the following computation.

Let the distance as he supposeth be 12000 foot, and the Capacity of each Receptacle be about one half of a cubick foot: I might make the wheel with the *Axis* to make their revolution in one minute of time, and so order all things that the Air under the ascending plugs might come to be rarefied to such a degree, that by its Elasticity it might not counterpoise more than 7 foot of water: but at the same time the Air in the Receptacles A A, B B, would even in it's greatest dilatation be able to counterpoise 17 foot: so it is plain that the Air will be driven from the Receptacles into the Pumps by a strength equivalent to ten foot of water: Now if we compute after the method publish'd in the Transacti-
on of the month of *October* last, what should be the Velocity of the Air driven by such a pressure: we shall find that the said Velocity will be about 740 foot in a second: So that in half a minute, during which the plug goeth up, this Air might pass above 22000 foot, although it were not rarifi'd at all; but being rarefi'd, as we do suppose it to be, it might go a great deal further.

I must now take notice that according to the Honourable Mr. *Boile's* Experiments quoted by Mr. *Nuis*, the Rarefaction of the Air is much lesser than he takes it to be: For the Water contain'd in the Pipe N O. is so far from causing the Air to fill up a space four times bigger, that it will not extend it self to a space once bigger than before; considering therefore the Velocity of the Air and the small dilatation it doth suffer, if any one will take the trouble to compute, he will find that if the Pumps have in Diameter the Diagonal of a Square Foot, and the same height: and if the small Tubes of communication be made of $\frac{1}{2}$ part of an Inch in Diameter, so that being 12000 Foot long, they may contain about one cubick Foot of
 Air:

Air, that would be more than sufficient to make the necessary Rarefaction in the Receptacles: And thus much might answer Mr. *Nuis* his Objection.

But for the good success of the Engine it is not enough to make the Air pass from the Receptacles into the Pumps, it must also return from the Pumps into the Receptacles: Now for this intent it would be necessary to set the Receptacles but five Foot above one another; so to drive the Water up the Pipe *NO*, it would be enough that the Air in the Receptacle *B* should press with a strength equivalent to 23 Foot of Water: For it is plain that 5 Foot in the Pipe *NO*, together with a pressure equivalent to 17 Foot which I have supposed to be in the upper Receptacle *A*, will make but 22 Foot in all: and therefore 23 Foot pressing in the Receptacle *B* must prevail and cause the Water to ascend: now the pressure in the Receptacle being but 23 Foot, and the Air in the Pump returning to its ordinary pressure, which is about 33 Foot; it is plain that the Air going back to the Receptacle will be driven by a strength equivalent to 10 Foot, as well as it had been in coming from the Receptacle towards the Pump: and so the bigness assigned for the communication-Pipes will also prove more than sufficient to this effect.

From what I have been saying it is plain, that in great distances there should be made as many Pumps as Receptacles, as I had propounded in the first explication of my Engine: and for to raise Water but 60 Foot high, there should be required 13 or 14 Receptacles and as many Pumps of the bigness aforesaid. Some people may take this for a great difficulty. But I answer that in this Engine this is not so much as it seems at first; because the pressure being all from without, there is no need of any great strength to resist it, and so the Metal for the Pumps will cost but little: there may also be found occasions where to make so good use of them, that such an Engine as I have described would in a years time save labour enough to pay for

for many Pumps, since it might every hour raise about 1800 pounds of Water to the height of 60 Foot: Mean while I don't pretend to have given here the best proportion for the bigness of every part of the Engine; but it may be, by altering the Capacity of the Pumps, of the Pipes, or of the Receptacles, a much more considerable effect might be produced: but I'll leave this to be lookt after by those that may have occasion for it; and for my part I content my self having shewn the truth of what I had at first, though but doubtfully, propounded: For the River *Seine*, where it is nearest to *Versailles*, not being above 20000 Foot distant, it is easie to see that, to supply this increase of distance, we might lessen at pleasure the capacity of the Receptacles, or increase the capacity of the Pumps and of the Pipes, or cause the wheel to spend more time in its revolution: 'tis true the Engine would produce less effect, but upon a great River the number of the Engines might be multiplied, and vast quantitys of Water still be raised. I shall therefore, to prevent new difficulties, add only this: that as well as in the Receptacles I have a way to prevent the overflowing with Water; so in the Pumps I might also prevent the overfilling with Air, by making a Valve that should open as soon as the Air in the Pump should be more compressed than the outward Air: So the Air getting in through any pores would constantly be let out.

As for the third objection wherein Mr. *Nuis* says that it doth not appear how the Water in our Engine may, by Rarefaction, ascend higher than 32 Foot. I answer that the Water doth not at any time ascend higher than from a lower Receptacle into the next upper Receptacle, which height is but 12 Foot: So that it is plain enough that the pressure of the Air may be sufficient to drive it up. It is indifferent whether it be by Rarefaction or otherwise that the Water comes into the Receptacle *A*; it is enough that the Water is there, and that the Air presses upon

upon it with such a strength as will prevail against all that opposeth it, as I have shewn above.

To the fourth Difficulty I answer : That although the use of the Pipes be meerly for the conveying of Air : They may nevertheless easily be fill'd with Water when need requires, and so the defects in them may as well be found out as in the Pipes that are used for the conveying of Water. This is all I may answer at present, and I shall make an end with assuring Mr. *Nuis* that i'll make use of his advice when ever he will be pleased to give it me.

An answer of the same to the Author of the perpetual Motion.

IN the last papers I published in *Phil. Transact.* N. 184 against this perpetual Motion described in N. 177. I intreated the Author to permit me to say nothing as to what alterations he might make in his Engine ; resolving to leave it to others to shew him that upon that principle all he can do signifies nothing. But I find since, in the *Nouvelles de la Republ.* for December last, that he still persists to urge some new contrivances, which being added he conceives his Engine must succeed. To this I answer that I undertook only to shew that his first device would faile, which yet I should scarce have done, if I had thought a dispute of this nature could have lasted so long. To come therefore to the point, where he saith that this Engine may well succeed without alteration, because he hath tryed with Liquors put into Bellows immersed in Water : I again say that I grant him the truth of the Experiments, but deny the consequences he would
 LI draw

draw from them, I have already given the reasons of my dissent, which this Gentleman is not pleased to understand. But to end all controversies he may please to consult Mr. *Perrault, de la Hire*, or any other at *Paris* well known to be skilled in *Hydraulicks*: and I doubt not but he will find them of the same opinion with Mr. *Boyle*, Mr. *Hook* and other knowing persons here, who all agree that our Author is in this matter under a mistake.

*Occultatio Saturni a Luna plena, Anno 1687. Martii
19no. mane: observata a Dno Ed. Haines R. S. S. ad
Totteridg prope Londinum, sub Latitudine 51. 39.*

Ingruente Eclipsi, ad corrigendum Horologium Oscillatorium cepit aliquot Altitudines Pollucis. viz.

Horologii

Temp. corr

<i>H. m. s.</i>		<i>G. m.</i>	<i>H. m. s.</i>
12 06 10	<i>Alt. Pollucis</i>	28 35	12 12 14
10 05		28 00	
13 30		27 28	
16 47		26 59	12 22 47
1 18 00	<i>limbus tangebatur ansam occid. hni</i>		1 24 00
1 18 30	<i>Inmersio centri hni paulo infra Paludem Marcotin.</i>		1 24 30
1 19 00	<i>Jam Saturnus omnino latuit.</i>		1 25 00
	<i>Eodem die post meridiem</i>		
4 01 25	<i>Altitudo centri Solis.</i>	20 00	4 7 17
03 47		19 41	
06 20		19 18	
09 06		18 55	4 14 43

Emergio ob nubes videri non potuit.

A Dis-

A Discourse concerning the Measure of the Airs resistance to Bodies moved in it. By the Learned John Wallis S. T. D. & R. S. Soc.

1. **T**Hat the Air (and the like of any other *Medium*) doth considerably give resistance to Bodies moved in it ; (and doth thereby abate their Celerity and Force :) is generally admitted. And Experience doth attest it : For otherwise, a Cannon Bullet projected Horizontally, should (supposing the Celerity and Force undiminished) strike as hard against a perpendicular Wall, erected at a great distance, as near at hand : which we find it doth not.

2. But at what Rate, or in what Proportion, such resistance is ; and (consequently, at what Rate the Celerity and Force is continually diminished) seems not to have been so well examined. Whence it is, that the Motion of a Project (secluding this Consideration) is commonly reputed to describe a Parabolick Line ; as arising from an Uniform or equal Celerity in the Line of Projection, and a Celerity uniformly accelerated in the Line of Descent : which two so compounded, do create a Parabola.

3. In order to the computation hereof ; I first premise this *Lemma*, (as the most rational that doth occur for my first footing,) That (supposing other things equal) the resistance is proportional to the Celerity. For in a double Celerity, there is to be removed (in the same time) twice as much Air, (which is a double Impediment) in a treble, thrice as much ; and so in other Proportions.

4. Suppose we then the Force impressed (and consequently the Celerity, if there were no resistance) as 1 ; the resistance as r . (which must be less than the Force, or else the Force would not prevail over the Impediment, to create a Motion.) And therefore the effective Force at a first Moment, is to be reputed as $1 - r$: That is, so much as

L 1 2 the

the Force impressed, is more than the Impediment or Resistance.

5. Be it as $1-r$ to 1 ; so 1 to m . (which m is therefore greater than 1 .)

6. And therefore the effective Force (and consequently the Celerity) as to a first Moment, is to be $\frac{1}{m}$ of what it would be, had there been no resistance.

7. This $\frac{1}{m}$ is also the remaining Force after such first Moment; and this remaining Force is (for the same Reason) to be proportionally abated as to a second Moment: that is we are to take $\frac{1}{m}$ thereof, that is $\frac{1}{m} \frac{1}{m}$ of the impressed Force. And for a third Moment (at equal distance of time) $\frac{1}{m} \frac{1}{m} \frac{1}{m}$; for a fourth $\frac{1}{m} \frac{1}{m} \frac{1}{m} \frac{1}{m}$; and so onward infinitely.

8. Because the length dispatched (in equal times) is proportional to the Celerities; the Lines of Motion (answering to those equal Times) are to be as $\frac{1}{m}, \frac{1}{m}^2, \frac{1}{m}^3, \frac{1}{m}^4$, &c. of what they would have been, in the same Times, had there been no resistance.

9. This therefore is a Geometrical Progression; and (because of m greater than 1) continually decreasing.

10. This decreasing Progression infinitely continued (determining in the same point of Rest, where the Motion is supposed to expire) is yet of a Finite Magnitude;

and equal to $\frac{1}{m-1}$ of what it would have been in so much Time, if there had been no resistance. As is demonstrated in my Algebra, *Chap. 95. Prop. 8.* For (as I have elsewhere demonstrated) the Sum or Aggregate of a Geometrical Progression is $\frac{VR-A}{R-1}$ (supposing V the greatest

term, A the least, and R the common multiplier.)

That is $\frac{VR}{R-1} - \frac{A}{R-1}$. Now in the present Case, (supposing the Progression infinitely continued) the least term A , be-

becomes infinitely small, or $= 0$. And consequently $\frac{A}{R-1}$ doth also vanish, and thereby the Aggregate becomes $= \frac{VR}{R-1}$. That is

(as will appear by dividing VR by $R-1$;) $V + \frac{V}{R} + \frac{V}{R^2} + \frac{V}{R^3} + \dots = \frac{VR}{R-1}$;

(supposing the Progression to begin at $V=1$.) That is

(dividing all by R , that so the Progression may begin at $\frac{V}{R} = \frac{1}{m}$;) $\frac{V}{R-1} = \frac{V}{R} + \frac{V}{R^2} + \frac{V}{R^3} + \dots$ That is, in our

present Case (because of $V=1, \& R=m$;) $\frac{1}{m} + \frac{1}{m^2} + \frac{1}{m^3} + \dots = m-1$. That is, (putting $n = m-1$) $\frac{1}{n}$ of what it would have been if there had been no resistance.

11. This infinite Progression is fitly expressed by an ordinate in the exterior Hyperbola, parallel to one of the Asymptotes ; and the several Member of that, by the several Members of this, cut in continual Proportion. As is there demonstrated at *Prop. 15*. For let SH , (*vid. Fig. III.*) be an Hyperbola between the Asymptotes AB, AF : And let the ordinate DH (in the exterior Hyperbola, parallel to AF ;) represent the impressed force undiminished; or the Line to be described in such time, by a Celerity answerable to such undiminished force. And let BS (a like ordinate) be $\frac{1}{m}$ thereof ; which therefore, being less than

$$\begin{array}{r} R-1) VR(V + \frac{V}{R}, \frac{V}{R^2}, \text{ &c.} \\ \underline{VR-V} \\ + V \\ + V - \frac{V}{R} \\ \hline \frac{V}{R} \\ + \frac{V}{R} \\ + \frac{V}{R} - \frac{V}{R^2} \\ \hline \frac{V}{R^2} \\ + \frac{V}{R^2} \\ \hline \frac{V}{R^3} \\ \text{&c.} \end{array}$$

DH

DH (as being equal to a Part of it) will be further than it from AF . In AB (which I put $= 1$) let Bd be such a Part thereof, as is BS of DH . Now because (as is well known) all the inscribed Parellelograms, in the exterior Hyperbola, AS , AH , &c. are equal; and therefore their sides reciprocal: Therefore as $Ad = 1 - \frac{1}{m}$ (supposing Bd to be taken, from B toward A ,) to $AB = 1$, (or as $m - 1$ to m :) so is BS

$= \frac{1}{m} DH$, to dh , which is therefore equal to $\frac{1}{m - 1}$ of DH ; that is (as will appear by dividing 1 , by $m - 1$,) to $\frac{1}{m} + \frac{1}{m^2} + \frac{1}{m^3}$ &c. of DH .

Or if Bd be taken beyond B ; then as $Ad = 1 + \frac{1}{m}$, to $AB = 1$, or as $m + 1$ to m , so is $\frac{1}{m} DH$ to dh , which is therefore equal to $\frac{1}{m + 1} DH$; that is (as will appear by like dividing of 1 by $m + 1$;) = to $\frac{1}{m} - \frac{1}{m^2} + \frac{1}{m^3}$ &c. of DH .

$$\begin{aligned} & m - 1) \quad 1 \left(\frac{1}{m} + \frac{1}{m^2} + \frac{1}{m^3} + \&c. \right. \\ & \quad \underline{1 - \frac{1}{m}} \\ & \quad \quad + \frac{1}{m} \\ & \quad \quad \underline{+ \frac{1}{m} - \frac{1}{m^2}} \\ & \quad \quad \quad + \frac{1}{m^2} \\ & \quad \quad \quad \underline{+ \frac{1}{m^2} - \frac{1}{m^3}} \\ & \quad \quad \quad \quad + \frac{1}{m^3} \\ & \quad \quad \quad \quad \underline{+ \frac{1}{m^3} - \frac{1}{m^4}} \\ & \quad \quad \quad \quad \quad + \frac{1}{m^4} \\ & \quad \quad \quad \quad \quad \&c. \end{aligned}$$

12. Let such ordinate dh , or (equal to it in the Asymptote) AF , be so divided in L , M , N &c. (by perpendiculars cutting the Hyperbola in l , m , n , &c.) as that FL , LM , MN be as $\frac{1}{m}$, $\frac{1}{m^2}$, $\frac{1}{m^3}$ &c. That is, so continually decreasing, as that each antecedent be to its consequent, as 1 to m , or as m to 1 . See Fig. IV

13. This is done by taking AF , AL , AN , &c. in such proportion. For, of continual proportionals the differences are also continually proportional, and in the same pro-

proportion. For let A, B, C, D , &c. be such proportionals;
and their differences a, b, c , &c. That is $A - B = a, B - C = b, C - D = c$, &c.

Then, because A, B, C, D , &c. are in continual proport:

That is $A. B :: B. C :: C. D :: \&c.$

And dividing $A - B. B :: B - C. C :: C - D. D :: \&c.$

That is $a. B :: b. C :: c. D :: \&c.$

And alternly $a. b. c. \&c. :: B. C. D. \&c. :: A. B. C. \&c.$

That is, in continual proportion as A to B , or as m to 1 .

14. This being done; the Hyperbolick spaces Fl, Lm, Mn , &c. are equal. As is demonstrated by *Gregory San-Vincent*; and as such is commonly admitted.

15. So that Fl, Lm, Mn , &c. may fitly represent equal times, in which are dispatched unequal lengths, represented by FL, LM, MN , &c.

16. And because they are in number infinite (though equal to a finite Magnitude) the duration is infinite: And consequently the impressed force, and motion thence arising, never to be wholly extinguished (without some further impediment) but perpetually approaching to A , in the nature of Asymptotes.

17. The spaces Fl, Fm, Fn , &c. are therefore as Logarithms (in Arithmetical progression increasing) answering to the lines AF, AL, AM , &c.; or to FL, LM, MN , &c. in Geometrical progression decreasing,

18. Because FL, LM, MN , &c. are as m, m^2, m^3 , &c. (infinitely) terminated at A ; therefore (by ¶ 10) their Aggregate FA or dh , is to DH , (so much length as would have been dispatched, in the same time, by such impressed force undiminished) as 1 to $m - 1 = n$.

19. If therefore we take, as 1 to n , so AF to DH ; this will represent the length to be dispatched, in the same time, by such undiminished force.

20. And if such DH be supposed to be divided into equal parts innumerable (and therefore infinitely small;) these answer to those (as many) parts unequal in FA , or hd .

21. But, what is the proportion of r to 1 , or (which depends on it) of $1 - r$ to 1 , or 1 to m ; remains to be inquired by experiment.

22. If the progression be not infinitely continued; but end (suppose) at N , and its least term be $A = MN$: then,

out of $\frac{V}{R-1} = \frac{1}{m} + \frac{1}{mm} + \frac{1}{m^3}$, &c. is to be subducted

$\frac{A}{R-1}$ (as at ¶ 10) that is (as by division will appear)

$\frac{A}{R} + \frac{A}{R^2} + \frac{A}{R^3}$ &c. That is (in our present case) $\frac{a}{m} +$

$\frac{a}{mm} + \frac{a}{m^3}$ &c. And so the Aggregate will be $\frac{1-a}{m} + \frac{1-a}{mm}$

$+ \frac{1-a}{m^3}$ &c. $= \frac{1-a}{m}$.

And thus as to the line of Projection, in which (secluding the resistance) the motion is reputed uniform; dispatching equal lengths in equal times. Consider we next the line of Descent.

23. In the Descent of Heavy Bodies, it is supposed, that to each moment of time, there is superadded a new Impulse of Gravity to what was before: And each of these, secluding the consideration of the Airs resistance, to proceed equally (from their several beginnings) through the succeeding moments. As (in the erect lines)

1 1 1 1 &c. 1 1 1 &c, 1 1 &c. 1 &c. and so continually as in the line of Projection.

24. Hence ariseth (in the transverse lines) for the first moment 1, for the second 1 + 1, for the third 1 + 1 + 1, and so forth, in Arithmetical progression: As are the Ordinates in a Triangle, at equal distance.

25. And such are the continual increments of the Diameter, or of the ordinates in the exterior Parabola, answering to the interior Ordinates, or Segments of the Tangent

gent, equally increafing. As is known, and commonly admitted.

26. If we take-in the confideration of the Airs refiftence; we are then for each of thefe equal progrefions, to fubftitute a decreafing progreflion Geometrical; in like manner (and for the fame reasons) as in the line of Projection.

27. Hence arifeth, for the firft moment m ; for the fecond $m + m^2$; for the third $m + m^2 + m^3$ &c. And fuch is therefore the Defcent of a heavy Body falling by its own weight. The feveral impulſes of Gravity being fuppoſed equal.

$$\begin{array}{ccccccc} & & & & \frac{1}{m} & & \\ & & & & m & & \\ & & & & \frac{1}{m^2} & \frac{1}{m} & \\ & & & & m^2 & m & \\ & & & & \frac{1}{m^3} & \frac{1}{m^2} & \frac{1}{m} \\ & & & & m^3 & m^2 & m \\ & & & & \frac{1}{m^4} & \frac{1}{m^3} & \frac{1}{m^2} & \frac{1}{m} \\ & & & & m^4 & m^3 & m^2 & m \end{array}$$

28. That is (in the figure of ¶ 12) as FL, FM, FN , &c. in the line of Defcent, anſwering to FL, LM, MN , &c. in the line of Projection.

29. But though the Progrefions for the line of Projection, are like to each of thoſe many in the line of Defcent:

it is not to be thence inferred, that therefore m in the one, is equal to m in the other: But in the line of Projection

(ſuppoſe) $\frac{1}{m} f$ (ſuch a part of the force impreſſed, and

a celerity anſwerable:) in the line of Defcent, $\frac{1}{m} g$ (ſuch a part of the Impulſe of Gravity.)

30. Thoſe for the line of Defcent (of the ſame Body) are all equal, each to other: Becauſe g (the new Impulſe of Gravity) in each moment is ſuppoſed to be the ſame.

31. But what is the proportion of f to g (that of the force impreſſed, to the Impulſe of Gravity in each Body) remains to be enquired by Experiment.

32. This proportion being found as to one known force; the ſame is thence known as to any other force

M m

(who's

(who's proportion to this is given) in the same uniform *Medium*.

33. And this being known as to one *Medium*; the same is thence known as to any other *Medium*, the proportion of who's resistance to that of this is known.

34. If a heavy body be projected downward in a perpendicular line; it descends therefore at the rate $\frac{1}{m}$, $\frac{1}{mm}$, $\frac{1}{m^3}$, &c. of f (the impressed force) increased by $\frac{1}{m}$, $\frac{1}{m} + \frac{1}{m^2}$, $\frac{1}{m} + \frac{1}{m^2} + \frac{1}{m^3}$ &c. of g the impulse of Gravity : (by ¶ 7. & ¶ 27.) Because both forces are here united.

35. If in a perpendicular projection upwards; it ascends in the rate of the former, abated by that of the latter. Because here the impulse of Gravity is contrary to the force impressed.

36. When therefore this latter (continually increasing) becomes equal to that former (continually decreasing) it then ceaseth to ascend; and doth thenceforth descend at the rate wherein the latter continually exceeds the former.

37. In an Horizontal or Oblique projection: If to a Tangent who's increments are as FL , LM , MN , &c; that is as $\frac{1}{m}f$, &c. be fitted Ordinates (at a given angle) who's increments are as FL , FM , FN , &c. that is as $\frac{1}{m}g$, &c: The Curve answering to the compound of these Motions, is that wherein the Project is to move.

38. This Curve (being hitherto without a name) may be called *Linea Projectorum*; the line of Projects, or things projected; which resembles a Parabola deformed.

39. The Celerity and Tendency, as to each point of this line, is determined by a Tangent at that Point.

40. And that against which it makes the greatest stroke
or

or percussive, is that which (at that point) is at right angles to that Tangent.

41. If the Projection (at ¶ 27.) be not infinitely continued, but terminate (suppose) at N , so that the last term in the first Column or Series erect be a ; and consequently in the second, ma ; in the third, $mm a$, &c. (each Series having one term fewer than that before it :) then (for the same reasons as at ¶ 22.) the Aggregates of the several Columns (or erect Series) will be $\frac{1-a}{n}$, $\frac{1-ma}{n}$,

$\frac{1-mma}{n}$, and so forth, till (the multiple of a becoming $= 1$) the progression expire.

42. Now all the abatements here, a , ma , mma , &c. are the same with the terms of the first Column taken backward. For a is the last, ma the next before it; and so of the rest.

43. And the Aggregate of all the Numerators is so many times 1 as is the number of terms (suppose t ,) wanting the first Column; that is $t - \frac{1-a}{n}$, or $\frac{nt-1+a}{n}$; & this again divided by the common denominator n , becomes $\frac{nt-1+a}{nn}$. And therefore $\frac{nt-1+a}{nn} g$, is the line of descent by its own Gravity.

44. If therefore this be added to a projecting force downward in a perpendicular; or subducted from such projecting force upward; that is, to or from $\frac{1-a}{n} f$: The Descent in the first case will be $\frac{1-a}{n} f + \frac{nt-1+a}{nn} g$; and the Ascent in the other case $\frac{1-a}{n} f - \frac{nt-1+a}{nn} g$. And in this latter case, when the ablative part becomes equal to the positive part, the Ascent is at the highest: and

M m thence-

thenceforth (the ablative part exceeding the positive) it will descend.

45. In an Horizontal or Oblique projection; having taken $\frac{1-a}{n}f$ in the line of Projection, and thence (at the Angle given) $\frac{nt-1+a}{nn}g$ in the line of Descent; the point in the Curve answering to these, is the place of the Project answering to that moment.

46. I am aware of some Objections to be made, whether to some points of the Process, or to some of the Suppositions. But I saw not well how to wave it, without making the Computation much more perplexed. And in a matter so nice, and which must depend upon Physical Observations, t'will be hard to attain such accuracy as not to stand in need of some allowances.

47. Somewhat might have been further added to direct the Experiments suggested at ¶ 21. and 31. But that may be done at leisure, after deliberation had, which way to attempt the Experiment.

48. The like is to be said of the different resistance which different Bodies may meet with in the same *Medium*, according to their different Gravities (extensively or intensively considered) and their different figures and Positions in Motion. Whereof we have hitherto taken no account; but supposed them, as to all these, to be alike and equal.

Post-script.

49. The computation in ¶ 41, 42, 43, may (if that be also desired) be thus represented by Lines and Spaces. The Ablatives $a, m a, m m a$, &c. (being the same with the first Column taken backward) are fitly represented by the segments of $N F$ (beginning at N) in Figure IV. and V. and therefore by Parallelograms on these Bases, assuming the common height of $F b$, or $N Q$: the Aggregate of which

is

is Nb , or FQ . And, so many times 1, by so many equal spaces, on the same Bases, between the same Parallels terminated at the Hyperbola: The Aggregate of which is $bFNQ_n$. From whence if we subduct the Aggregate of Ablatives FQ ; the remaining trilinear bQ_n , represents the Descent.

50. If to this of Gravity, be joyned a projecting Force; which is to the impulse of Gravity as bK to bF (be it greater, less, or equal) taken in the same line: the same parallels determine proportional Parallelograms, whose Aggregate is KQ .

51. And therefore if this be a Perpendicular Projection downwards; then $bKkn$ (the summe of this with the former) represents the Descent.

52. If it be a Perpendicular upwards; then the difference of these two represents the Motion: which so long as KQ is the greater, is Ascendent: but Descendent when bQ_n becomes greater: and it is then at the highest when they be equal.

53. If the Projection be not in the same Perpendicular, (but Horizontal, or Oblique) then KQ represents the Tangent of the Curve; and bQ_n the Ordinates to that Tangent, at the given Angle.

54. But the Computation before given I take to be of better use than this representation in Figure. Because in such Mathematical enquiries, I choose to separate (as much as may be) what purely concerns Proportions; and consider it abstractly from lines or other matter where-with it is incumbered.

As to the question proposed; whether the resistance of the *Medium* do not always take off such a proportional part of the force moving through it, as is the Specifick Gravity of the *Medium* to that of the Body moved in it: (for, if so, it will save us the trouble of Observation.)

I think this can by no means be admitted. For there be many other things of consideration herein, beside the In-

tensive Gravity (or, as some call it, the Specifick Gravity) of the *Medium*.

A viscous *Medium* shall more resist, than one more fluid, though of like Intensive Gravity.

And a sharp Arrow shall bore his way more easily through the *Medium*, than a blunt headed Bolt, though of equal weight, and like intensive Gravity.

And the same Pyramide with the Point, than with the Base forward.

And many other like varieties, intended in my ¶ 43.

But this I think may be admitted, namely, That different *Mediums*, equally liquid, (and other circumstances alike,) do in such proportion resist, as is their Intensive Gravity. Because there is, in such Proportion, a heavier object to be removed, by the same Force. Which is one of the things to which ¶ 33. refers.

And again: The heavier Project once in motion, (being equally swift, and all other circumstances alike) moves through the same *Medium* in such proportion more strongly, as is its Intensive Gravity. For now the Force is in such proportion greater, for the removal of the same resistance. And this part of what my ¶ 32. insinuates.

But where there is a complication of these considerations one with another, and with many other circumstances whereof each is severally to be considered: there must be respect had to all of them.

Part of a Letter from Mr. William Cole of Bristol to the Publisher, about the Grains resembling Wheat which fell lately in Wilt-shire.

———This City and Country round about, is filled with Reports of Raining Wheat about *Warminster*, and other Places within Six or Eight Miles of it, and many believe it; I have procured several Parcels of it, and carefully examined them, and find it to be the seeds of *Ivy-Berries*, which from Towers and Churches, Chimneys, Walls and high Buildings, were lately by very fierce Tempests of Wind and Hail, driven away from the holes, chinks and other parts where Birds had brought them, especially *Sterlings* and *Cloughs*: It were to little purpose to tell you the prodigious Stories which have been made of it; among many others, it was confidently affirmed (and backt by several, who affirmed they had seen it) that those Grains were found in the Hail, as Seeds in Comfits: I do here acquaint you with it (upon Notice I had of some who have sent several Parcels of it to your Society, with strange Relations of it) to the end you may inform them of the Truth; For I have by all the ways I can Imagine examined and compared them with the Seeds of *Ivy Berries*, by the tast, smell, size, and Figure; with the assistance of Magnifying Glasses, viewing them in both the superficial and inward Parts. This perhaps they may have discovered before this comes to their Hands, if they desire farther Satisfaction concerning it, I shall be ready to serve them, &c.

William Cole.

An Extract of a Letter written by Mr. Veay Physician at Tholouse to Mr. de St. Ussans, concerning a very extraordinary Hermaphrodite in that City. Communicated by Dr. Aglionby. Reg. Soc. S.

JE veux Monsieur, vous faire part d'une chose fort extraordinaire, qui m'est arrivée il y a quelques jours dans l'Hospital S. Jacques, au quartier des femmes, ou je suis de tour pendant ce semestre. On apporta une servante malade Hermaphrodite. Elle est du lieu de Pourdiac a sept lieues de Tholouse. Elle a été baptisée en qualité de fille, sous le nom de Marguerite. Son Pere est pauvre homme de Pourdiac, qu'on appelle Malaufe. Elle est âgée de 21 a 22 ans, ayant bien la mine extérieure d'une fille, mais les marques réelles d'un homme bien puissant. Son visage est féminin & assez agreable, la gorge bien jolie, & les mammelles aussi bien faites qu'on les puisse désirer a une fille, les fesses & les cuisses grandes comme aux femmes, les parties honteuses tout comme celles d'une femme, mais elle n'est percée que de la profondeur de deux petits travers de doigts ; & au milieu de cette fente, il pend un membre viril d'une grosseur fort considerable, & qui dans l'erection luy sort au dehors d'environ huit pouces. Ce membre est bien formé, hormis qu'il n'a point de prepuce, & qu'il n'est pas accompagné de testicules apparens. L'urine & la semence en sortent comme aux hommes, & ce qu'il y a de particulier, c'est que le sang menstrual coule aussi par ce même conduit de la Verge.

J'aurois eu de la peine a le croire, si je ne l'auois veu moy-même, & examiné fort exactement dans le temps que ses menstrues couloient, lesquelles luy survennent presque tous les mois assez regulierement, ne passant gueres deux mois de temps sans les avoir ; mais presque toujours avec de grandes douleurs & une tension au bas ventre qui marque une espece d'inflammation dans ces parties.

J'ay

J'ay fait voir cela a plusieurs de nos medecins, & apres avoir consulté Messieurs les Vicaries Generaux, nous luy avons fait prendre un habit d'homme, sous le nom d' Arnaud Malaufe; & on va presentement luy faire apprendre quelque metier. Il n' y avoit pas a hesiter la dessus, parce que notre Hermaphrodite peut fort bien faire la fonction d' homme, & point du tout celle de femme.

J'ay cru vous faire plaisir de vous ecrire ce fait, qui commence deja d'etre public dans cette ville, mais qui est bien rare, & bien extraordinaire.

Tholose

Decemb. 4. 1686.

Accounts of B O O K S.

I. *Historia Plantarum, species haëtenus editas aliasq; insuper multas noviter inventas & descriptas complectens &c.* Autore Joanne Rajo e Societate Regia. *Tomus primus.* Londini, 1686 Fol. Apud Henricum Faithorne R.S. Typographum; ad insigne Rosæ in Cæmeterio D. Pauli.

THe excellent Author of this great Work, is so well known for his incomparable Skill in the *Botanick* Science, and other Parts of useful Learning, that it will be needless to say any thing of him. The Forreign Journals haying given Accounts of this Book have prevented the mentioning of many particulars, but they only speaking in general, and *per saltum*, neglecting the Divisions, Subdivisions, and the Method; I shall therefore only confine my self to those Particulars.

The *First Tome* contains 18 Books, to which are premised a *Botanick Lexicon*, or Interpretation of Terms of Art;

together with an Account of most of the Writers that have handled the Subject of Plants. The first Book treats of Plants in general; as of their Roots, Stalks, Sap, Juices, their Motions, and Differences; of Gems or Buds, Leaves, Flowers, Fruits, Seeds, Clavicles or Climbers, Prickles, their Varieties, and Vegetations; of Sowing, Propagating, Cultivating, Grafting, or Inoculating; of the Transmutation of Plants, their Statures or Magnitudes, their Ages or Duration, their Faculties, Tasts, and Uses, their Places, and Divisions; of Collecting, Drying, and Preserving them, their Chymical *Analysis*, and their Diseases.

The 2d. Book begins with Particulars, as the imperfect Plants, such as seem to have no Flower or Seed; these are either *Submarine*; as the *Corals*, *Sponges*, *Alga's*, *Wracks*, &c. or *Terrestrial*, as the *Mushrooms*, and barren *Mosses*. Or *Subterraneous*, as the *Truffles*; some of the *Fungi* and *Mosses*, have visible Seeds: These are all subdivided into subordinate *Genera*, as the *Mushrooms* according to their *Lamellæ*, *Plates*, *Brim*s, and *Caps*; and as they are noxious, or esculent; or grow upon Trees.

The 3d. Book contains the *Capillary* or *Acaulose* Herbs, which bear their very minute Seeds on the backs of their Leaves, that are conspicuous by the *Microscope*: These are subdivided according to their Leaves, as they are whole, entire and undivided; or variously cut, lacinated, pinnate, and ramose. Of this Kind are the *Ferns*, the *Spleenworts*, *Polypodies*, *Maiden-Hairs*, &c. which have nothing like a Flower.

The 4th. Treats of such Herbs as have an imperfect or staminate Flower, commonly call'd *Apetalose*, because it is not composed of *Petala* or tender fugacious coloured Leaves, only of a *Calyx* or Cup, of *Stamina* or Capillaments of Styles. These are subdivided, I. into such whose Fruits are not contiguous to their Flowers; as in *Hops*, *Hemp*, *Nettles*, *Spinache*, *Mercury*, *Palma Christi*, the *American* Phy-

Physick - Nut, &c. II. Into such that have a triquetrous, or triangular Seed, as the *Docks*, *Sorrels*, *Arsmarts*, *Knot-grass*, *Snake-weeds*. III. Into those that have round, compressed, and otherwise figured Seeds, as the *Pond-Weeds*, *Orraches*, *Sea-Purslane*, the *Blites*, the *Amaranthi*, the *Beets*, some *Kali's*, &c.

The 5th. Book begins with those that have a perfect planifolious Flower, or tender coloured *Petala*, or Leaves, that make up a compound Flower: these are, I. either *lactescent*, milky, and *pappose*, containing their Seeds in a *lanugo* or downy Substance; as the *Lettuces*, *Sow-thistles*, *Succorys*, *Hawk-weeds*, *Mouse-ears*, *Dandelyons*, *Scorzonera's* or *Viper-grass*, *Goats-beard*, &c. II. Such as have solid Seeds without any *pappus* or *lanugo*; as *Endive*, *Nipple-wort*, and some *Succorys*; these are *lactescent*.

The 6th. Book contains the Herbs that are not Milky, and yet bear their Seeds in a downy or *pappose* Substance, succeeding the Flowers; these have either radiated, discose, and flat Flowers; as *Colts-foot*, the *Conyza's* or *Flea-banes*, *Elecampane*, the *Star-worts*, the *Leopards Banes*, the *Golden Rods*, the *Stacha's*, the *Jacoba's* or *Ragworts*; or else the Flower is disposed into a *Tbyrsus* or Spike, as in the *Petasitis* or *Butter-bur*.

The 7th. Is of the capitate Herbs, whose Flowers are *fistular*, and whose Seeds are included in a *Squamosse Calyx* or cup, conglobated into a Head, fill'd with a *Pappus*: of this Kind are the *Blew-bottles*, *Saw-wort*, the *Jacea's* or *Knap-weeds*, the great *Centory*, the great *Burr-dock*, and most of the *Thistles*, which are sub-divided according to their Heads, Flowers, Prickles, Spots, Consistence of their Leaves, &c.

The 8th. Comprehends the *Corymbiferous*, that are not *Pappose*, these have either a radiated, or a naked Flower, and are subdivided according to the Colours of the *Barbula* and *Discus*, and from the Figures the Flowers make; of this Tribe are the *Sun-flowers*, the *Chrysanthemum's* and *Marigolds*, the *Tarrows*, *Daisies*, *Feverfew*, the *Lavender-cot-*

tons, the *Tansies*, *Wormwoods*, *Southernwoods*, *Mugworts*, *Scabioses*, *Teasels*, *Eringo*, the *Globe-thistle*, &c.

The 9th. Treats of the *Umbelliferous* Herbs, to which are premised some Herbs that are a little a Kin to the *Umbelli*, only they have a single Seed succeeding each Flower ; whereas the true *Umbelli* have two ; of the first Kind are many *Valerians*, the *Sea Lavenders*, the *Marvel of Peru*, *Agrimony*, *Burnit*, *Meadow-Rue*. *Fumitory*, &c. The genuine *Umbelli* have *Pentapetalous* Flowers, to each of which, succeed two naked Seeds joined together ; these are put under so many sub-divisions, according to the various Figures of their Seeds, and Leaves ; of this *Umbelliferous* Family are the *Parsneps*, the *Fennels*, the *Angelica's*, the *Cummins Parslys*, *Hemlocks*, *Smallage*, *Aniseed*, *Caramays*, the *Carrots*, *Coriander*, &c. all which are very nicely distinguished, and variously sub-divided.

The 10th. Contains the *Stellate* Herbs, whose Leaves like a radiated *Star* embrace the Stalk ; their Flowers are *Monopetalous*, tho' divided or cut into four Segments, or coloured Leaves ; to each Flower there generally succeeds two Seeds ; of this Kind are the *Madders*, the *Crosworts*, the *Ladies Bed-straw*, the *Wood-roads*, the *Cleavers* or *Goose-grafs*, &c. The second Section of this Book, comprehends the *Asperifolious* Herbs, whose Flowers are *Monopetalous*, and generally reflected at the end like a *Scorpions Tail*, yet cut into five *Margins* or *Segments* ; to every one of these Flowers succeed for the most part four Seeds ; of this Kind are the *Pulmonaria Maculosa*, or *Sage of Jerusalem*, the *Hounds-Tongues*, *Borage*, *Bugloss*, *Alkanet*, the *Heliotropes* or *Turnsoles*, the *Gromils*, *Scorpion-grafs*, *Comfrey*, the *Honey-Worts*, &c.

The 11th. is of the *Verticillate* Herbs, so called from the Flowers embracing the stalk like a whirl, or wherle, the Leaves are generally placed together exactly opposite on the Stalk, the Flowers are *Monopetalous*, *labiated* for the most part or *galeated* ; to each Flower succeeds 4 Seeds, which

which the *Calyx* or *Perianthium* serves instead of a Vessel; these are subdivided according to their substance and duration, as they are *Lignous*, *Fruticose*, *Perennial*, and *Herbaceous*. Of this tribe are the *Sages*, the *Lavenders*, *Rosemary*, the *Hyssops*, the *Savoury's*, *Thymes*, *Poley-mountain*, the *Germanders*, the *Mints*, *Penneroyalls*, *Vervain*, the *Majorams*, *Basil*, the *Clarys*, *Betonys*, *Marrubiums*, *Laniums*, *Sideritis*, *Ground-Ivy*, *Baulm*, *Calamint*, *Ground-pine*, *Bugle*, &c.

The 12th. Comprehends those Herbs, to each of whose Flowers succeed more than 4 naked Seeds, whose number is indefinite, they being *Polyspermous*; here we may note that Mr. Ray takes those for naked Seeds whose *Follicules* or *Covers* (if they seem to have any) are not cast off, but fall with the Seeds from the mother Plant, being not separable from them. Of this family are the *Hepatica's*, the *Ranunculi*, the lesser *Celandine*, some *Mallows* and *Althaea's*, *Avens*, *Strawberries*, *Cinquefoils*, *Tormentill*, &c. The second Section of this Book is of such Herbs as have many naked Seeds, and a Flower without any *Perianthium* or *Calyx*, as the *Travellers-joy*, and some *Climbers*, *Dropwort*, *Meddow-sweet*, the *Anemonies*, *Pasque-flowers*: Those of the former Section having *Perianthia* or *Cups* about their Flowers.

The 13th. Is of the *Pomiferous*, and *Bacciferous* Herbs, these are distinguished by the *Magnitude*, and *Skins* of their Fruits; the Flowers are naked, *Monopetalous*, divided into five *Margins* or *Segments*, placed on the top of the Fruit like a *Corolla* or *Umbilicus*. Of this kind are the *Gourds*, the *Pompions*, the *Coloquintida*, the *Citruls*, *Melons*, *Cucumbers*, the *Passion-flowers*, &c. *China*, *Bryony*, *Solomon's-seals*, *Solanum's* or *Nightshades*, *Mandrakes*, *Capsicum's* or *Guinny pepper*, *Sparagus*, *Lillies* of the *Vallie*. &c.

The 14th. Contains the *Multisiliquose* or *corniculated* Herbs, which after each Flower bear many *Pods* or *horned Seed Vessels*. Of this kind are some *Sedums* or *House-leecks*,

Leeks, Orpines, Peionys, black Hellebore, some Althea's, Monks-hoods, Columbines, Larks-spur's.

The 15th. Is of such Herbs as have a uniform *Monopetalous* Flower, and besides the *Calyx* of the Flower have a distinct and proper Seed Vessel, such as are the *Henbanes*, the *Tobacco's*, the *Gentians*, the *Convolvuli* or *Bind-weeds*, the *Bell-flowers*, *Throatworts*, *Rampions*, *Stramonium's* or *Thorn Apples*: The other Section is of the deform'd *Monopetalous* Herbs, both of which are subdivided according to the Figures and Valves of the seminal Vessels, of this last kind are the *Butterworts*, the *Toad-flax* or *Linaria*, *Birthworts*, *Figworts*, *Foxgloves*, *Cock-combs* or *Rattles*, *Eyebrights*, *Cow-wheats*, &c.

The 16th. Treats of such Herbs as have a uniform *Tetrapetalous* or four leav'd Flower with a *deciduous quadrifolious Calyx* or *Perianthium*, to which succeed long or broad Seed Vessels, or short ones: the first are *Siliquose*, the other *Capsular*; of these kinds are the *Stock-gilliflowers*, the *Wallflowers*, *Toothworts*, *Rockets*, *Mustards*, *Cabbages*, *Colliflowers*, *Turneps*, *Radishes*, *Cresses*, *Scurvigrasses*, &c. all which are subdivided according to their various Pods, and *Capsula's*. To these are subjoyn'd many *Anomalous tetrapetalous* Herbs, or rather *Monopetalous*, their Flowers being lacinated or cut into 4 parts; of this latter kind are some *Veronica's* or *Speedwells*, some *Chickweeds*, *Brooklimes*, *Poppies*, some *Lysimachia* or *Willow-herbs*, *Rues*, the *Spurges*, *Plantaines*, &c, these make the 17th. Book.

The 18th. and last Book of the first Tome comprehends the *Legumes* or *Papilionaceous* Herbs, whose Flower somewhat represents a Butterfly with expanded wings, and is properly a deform'd *Monopetalous* Flower, tho' lacinated into 4 unequal Segments. These are divided I. into such *Legumes* as climb, and run up sticks, or perches, as the *Kidney Beans*, *Pease*, *Tares*, *Vetches*, *Lentills*, &c. II. into such as have no clasps, and doe not climb, neither are trifoliated, these are subdivided into many subordinate genera,

genera, according as their Pods are simple and erect, as in *Lupines*, *Beans*, common *Liguorice*, *Goats-Rue*; or *echinated* and *monospermous*, as in *Cocks-head*; or propendent, as in the *Orobi*, *Astragoli* or *Heath-Pease*, *Chiches*; or as their Cods are included or hid in Bottles, or Vesicles, as in the *Anthyllis*; or joyned, as in some *Colutea's*, *Ferrum equinum*, *Ornithopodium* or *Birds-foot*; or double, containing a double Series of Seeds, as in the *Tragacanth*s, &c. The III. general division is into such Legumes as are trifoliated, which are variously subdivided, according as their heads are thicker or thinner spicated; or their Pods hid in the *Calyx*, or appear out of it, or are longer, shorter, intorted or cochleated; of these kinds are all the *Trefoils*, *Hares-foot*, *Melilots*, *Fenugreek*, *Anonis* or *Rest-Harrows* *Saint-form* or *Medick-Fodder*, the *Medica's* or *Snail Trefoils*, the *Loti* which are almost *Pentaphyllous* or five leaved Legumes, the *Cytisi* or *shrub Trefoils*; to these are subjoined many anomalous *siliquose* Herbs, very near a kin to the *Papilionaceous*; as several *Fumitorys*, *Acasia's*, *Mimosa's* or sensitive Plants.

So much for the general Method of this Book; as for the subdivisions of each tribe, they are so numerous and very nice, that I could not trace and set them down in this account for want of room and words: therefore the Reader is referr'd for them to Mr. Ray himself, who discovers in every part a vast Memory, a quick Apprehension, a clear Judgment, and a long Experience.

Before we leave this Work it may bee necessary to note, that all the Plants confusedly dispersed up and down in Books, are collected and Methodically digested in it, together with many new ones never before published; in the History of each Plant Mr. Ray observes this excellent Order, first he gives the *Etymologies*, then the *Characteristick* Notes of distinction, the best *Synonymous* Names, descriptions of all the parts, the times and places of Growth, and the uses as well Medicinal as Mechanical.

The

The second and last Tome is already far advanced in the Press, above 100 Sheets being work't off, and the whole will certainly be finished and published by the end of this Summer; this Volume will contain the *Pentapetalous* and *Polypetalous* Herbs, the *Bulbs* and those a kin to them, the *Culmiferous* and *Graminifolious*, as the *Corns*, *Grasses*, *Reeds*, *Rushes*, &c. After which follows the *Anomalous* or disorderly tribe of Herbs; and then the *Dendrology* or History of Trees and Shrubs begins, all which will be digested in a new and most natural Method; there will also be a very large Appendix. As soon as this Volume is published a particular account shall be given of it; in the mean time a short general Specimen of the *Dendrology* may be inserted, containing only a few of the principal heads.

First Mr. Ray divides the Trees into such as have *caudicem simplicem non ramosum*, and such as have *caudicem ramosum*: the first have a simple Stemme without any Branches, and produce but one great *Gemma* or Bud; the second that are *ramose*, are first distinguished into such as have *florem a fructu disjunctum seu remotum*, and such as have *florem Fructui contiguum*; of the first sort some have the Flower remote from the Fruit in the same Plant, and some *totis Plantis sejunctum*. Of such as have also the Flower contiguous to the Fruit, some have it *summo Fructui insidentem*, and others *imo Fructui adnascentem*; of the first of these (which have for the most part a *Corolla* or *Umbilicus* on the top of the Fruit) some contain their seed in *Pericarpio seu pulpa humida*, others in *materia Siccior*. Each of these may be divided according to the number of the Seeds which the Fruit contains, into those that have *Fructum monococcum, dicoccum, tricoccum, tetracoccum, pentacoccum*, and *polycoccum*; after the same manner also may the other sort which have *Florem imo Fructui adnascentem* be divided: there will be many other Heads, of which at large and in particular when the Work comes forth.

II. *Philosophiæ Naturalis Principia Mathematica*, Autore II. Newton Trin. Coll. Cantab. Soc. Matheseos Professore Lucasiano, & Societatis Regalis Sodali. 4to. Londini. Prostat apud plures Bibliopolas.

THIS incomparable Author having at length been prevailed upon to appear in publick, has in this Treatise given a most notable instance of the extent of the powers of the Mind; and has at once shewn what are the Principles of Natural Philosophy, and so far derived from them their consequences, that he seems to have exhausted his Argument, and left little to be done by those that shall succeed him. His great skill in the old and new Geometry, helped by his own improvements of the latter, (I mean his method of *infinite Series*) has enabled him to master those Problems, which for their difficulty would have still lain unresolved, had one less qualified than himself attempted them.

This Treatise is divided into three Books, whereof the two first are entituled *de Motu Corporum*, the third *de Systemate Mundi*.

The first begins with definitions of the Terms made use of, and distinguishes *Time*, *Space*, *Place* and *Motion* into absolute and relative, real and apparent, Mathematical and vulgar: shewing the necessity of such distinction. To these definitions are subjoyned, the Laws of Motion, with several Corollaries therefrom; as concerning the composition and resolution of any direct force out of, or into any oblique forces, (whereby the powers of all sorts of Mechanical Engines are demonstrated:) the Laws

of the reflection of Bodies in Motion after their Collision : and the like.

These necessary *Præcognita* being delivered, our Author proceeds to consider the Curves generated by the composition of a direct impressed motion with a gravitation or tendency towards a Center : and having demonstrated that in all cases the Areas at the Center, described by a revolving Body, are proportional to the Times ; he shews how from the Curve described, to find the Law or Rule of the decrease or increase of the Tendency or Centripetal forces (as he calls it) in differing distances from the Center. Of this there are several examples : as if the Curve described be a Circle passing through the Center of tendency ; then the force or tendency towards that Center is in all points as the fifth power or squared-cube of the distance therefrom reciprocally. If in the proportional Spiral, reciprocally as the cube of the distance. If in an Ellipse about the Center thereof directly as the distance. If in any of the *Conick* Sections about the *Focus* thereof ; then he demonstrates that the *VisCentripeta*, or tendency towards that *Focus*, is in all places reciprocally as the square of the distance therefrom ; and that according to the Velocity of the impressed Motion, the Curve described is an *Hyperbola* ; if the Body moved be swift to a certain degree than a *Parabola* ; if slower an *Ellipse* or Circle in one case. From this sort of tendency or gravitation it follows likewise that the squares of the Times of the periodical Revolutions are as the Cubes of the *Radii* or *transverse Axes* of the *Ellipses*. All which being found to agree with the *Phænomena* of the Celestial Motions, as discovered by the great Sagacity and Diligence of *Kepler*, our Author extends himself upon the consequences of this sort of *Viscentripeta* ; shewing how to find the *Conick* Section which a Bodie shall describe when cast with any velocity in a given Line, supposing the quantity of the said force known : and laying down several neat constructions to determine

termine the Orbs, either from the *Focus* given and two points or Tangents; or without it by five points or Tangents or any number of Points and Tangents making together five. Then he shews how from the Time given to find the Point in a given Orb answering thereto; which he performs accurately in the *Parabola*, and by concise approximations comes as near as he pleases in the *Ellipse* and *Hyperbola*: all which are Problems of the highest concern in Astronomy. Next he lays down the Rules of the perpendicular descent of Bodies towards the Center, particularly in the case where the tendency thereto is reciprocally as the square of the distance; and generally in all other cases, supposing a general quadrature of Curve lines: upon which supposition likewise he delivers a general method of discovering the Orbs described by a Body moving in such a tendency towards a Center, increasing or decreasing in any given relation to the distance from the Center; and then with great subtilty he determines in all cases the Motion of the *Apsides* (or of the Points of greatest distance from the Center in all these *Curves*, in such Orbs as are nearly Circular. Shewing the *Apsides* fixt, if the tendency be reciprocally as the square of the distance; direct in Motion in any *Ratio* between the Square and the Cube and retrograde; if under the Square; which Motion he determines exactly from the Rule of the increase or decrease of the *Vis Centripeta*.

Next the Motion of bodies in given Surfaces is considered, as likewise the Oscillatory Motion of Pendules, where is shewn how to make a *Pendulum* Vibrate always in equal times, tho' the center or point of tendency be never so near; to which, the Demonstration of Mr. *Hugens de Cycloide* is but a *Corollary*. And in another Proposition is shewn the Velocity in each Point, and the time spent in each part of the Arch described by the Vibrating Body. After this the Effects of two or more Bodies, towards each of which there is a tendency, is considered; and 'tis made out that two Bodies, so drawing or attracting each other, describe

about the common center of Gravity, Curve Lines, like to those they seem to describe about one another. And of three Bodies, attracting each other, reciprocally as the Square of the distance between their Centers, the various Consequences are considered and laid down, in several *Collarys* of great use in explicating the *Phænomena* of the *Moons* Motions, the Flux and Reflux of the Sea, the Precession of the *Equinoctial* Points; and the like.

This done our Author with his usual Acuteness proceeds to examine into the Causes of this Tendency or centripetal Force, which from undoubted Arguments is shown to be in all the great Bodies of the Universe. Here he finds that if a Sphere be composed of an infinity of Atoms, each of which have a *Conatus accedendi ad invicem*, which decreases in duplicate Proportion of the Distance between them; then the whole *Congeries* shall have the like tendency towards its Center, decreasing, in Spaces without it, in duplicate Proportion of the Distances from the Center; and decreasing, within its Surface, as the distance from the Center directly; so as to be greatest on the Surface, and nothing at the Center: and tho' this might suffice, yet to compleat the Argument, there is laid down a Method to determine the forces of Globes composed of Particles whose Tendencies to each other do decrease in any other *Ratio* of the Distances: Which Speculation is carryed on likewise to other Bodies not Spherical, whether finite or indeterminate. Lastly is proposed a Method of explaining the Refractions and Reflections of transparent Bodies from the same Principles; and several Problems solved of the greatest Concern in the Art of *Dioptricks*.

Hitherto our Author has considered the Effects of compound Motions in *Mediis non resistentibus*, or wherein a Body once in Motion would move equably in a direct Line, if not diverted by a supervening Attraction or tendency toward some other Body. Here is demonstrated what

would

would be the consequence of a resistance from a *Medium*, either in the simple or duplicate *Ratio* of the Velocity, or else between both: and to compleat this Argument is laid down a general Method of determining the density of the *Medium* in all places, which, with a uniform Gravity tending perpendicularly to the plain of the *Horizon*, shall make a *Project* move in any curve Line assigned; which is the 10th. *Prop. Lib. II.* Then the circular Motion of Bodies in resisting *Media* is determined, and 'tis shown under what Laws of decrease of Density, the Circle will become a proportional *Spiral*. Next the density and compression of Fluids is considered, and the Doctrine of *Hydrostatics* demonstrated; and here 'tis proposed to the Contemplation of Natural Philosophers, whether the surprising *Phenomena* of the Elasticity of the Air and some other Fluids may not arise from their being composed of Particles which flie each other; which being rather a Physical than Mathematical Inquiry, our Author forbears to Discuss.

Next the Opposition of the *Medium* and its Effects on the Vibrations of the *Pendulum* is considered, which is followed by an Inquiry into the Rules of the Opposition to Bodies, as their Bulk, Shape, or Density may be varied: Here with great exactness is an Account given of several Experiments tried with *Pendula*, in order to verify the foregoing Speculation, and to determine the quantity of the Airs Opposition to Bodies moving in it.

From hence is proceeded to the undulation of Fluids, the Laws whereof are here laid down, and by them the Motion and Propagation of Light and Sound are explained. The last *Section* of this Book is concerning the Circular Motion of Fluids, wherein the Nature of their *Vortical* Motions is considered, and from thence the *Cartesian* Doctrine of the *Vortices* of the Celestial Matter carrying with them the Planets about the *Sun*, is proved to be altogether impossible.

The III. and last Book is entituled *de Systemate Mundi*, wherein the Demonstrations of the two former Books are applyed to the Explication of the principal *Phænomena* of Nature: Here the verity of the *Hypothesis* of *Kepler* is demonstrated; and a full Resolution given to all the difficulties that occur in the *Astronomical* Science; they being nothing else but the necessary consequences of the *Sun*, *Earth*, *Moon*, and *Planets*, having all of them a gravitation or tendency towards their Centers proportionate to the Quantity of Matter in each of them, and whose Force abates in duplicate proportion of the Distance reciprocally. Here likewise are indisputably solved the Appearances of the Tides, or Flux and Reflux of the Sea; and the Spheroidical Figure of the *Earth* and *Jupiter* determined, (from which the precession of the Equinoxes, or rotation of the Earths Axis is made out,) together with the retrocession of the *Moons* Nodes, the Quantity and inequalities of whose Motion are here exactly stated *a priore*: Lastly the Theory of the Motion of Comets is attempted with such success, that in an Example of the great Comet which appeared in 1680, the Motion thereof is computed as exactly as we can pretend to give the places of the primary Planets; and a general Method is here laid down to state and determine the *Trajectoria* of Comets, by an easy Geometrical Construction; upon supposition that those Curves are *Parabolick*, or so near it that the *Parabola* may serve without sensible Error; tho' it be more probable, saith our Author, that these Orbs are *Elliptical*, and that after long periods Comets may return again. But such *Ellipses* are by Reason of the immense distance of the *Foci*, and smallness of the *Latus Rectum*, in the Parts near the Sun where Comets appear, not easily distinguished from the Curve of the *Parabola*: as is proved by the Example produced.

The whole Book is interspersed with *Lemma's* of General use in *Geometry*, and several new Methods applyed,
which

which are well worth the considering ; and it may be justly said, that so many and so Valuable *Philosophical Truths*, as are herein discovered and put past Dispute, were never yet owing to the Capacity and Industry of any one Man.

A D V E R T I S E M E N T ;

Whereas the Publication of these Transactions has for some Months last past been interrupted ; The Reader is desired to take notice that the care of the Edition of this Book of Mr. Newton having lain wholly upon the Publisher (wherein he conceives he hath been more serviceable to the Commonwealth of Learning) and for some other pressing reasons, they could not be got ready in due time ; but now they will again be continued as formerly, and come out regularly, either of three sheets, or five with a Cutt ; according as Materials shall occur.

L O N D O N,

Printed by J. Streater, and are to be sold by Samuel Smith at the Princes Arms in St. Paul's Church-yard.

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Fig. 1

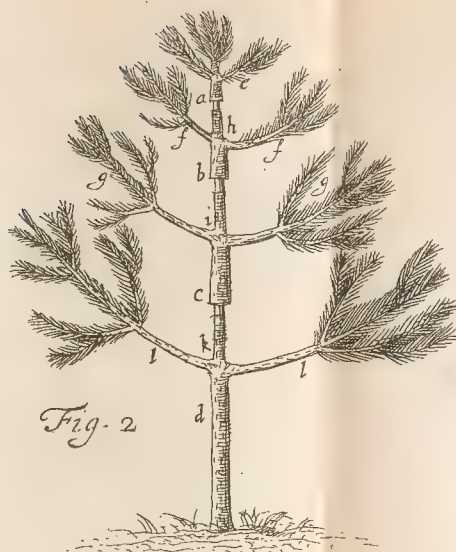


Fig. 2

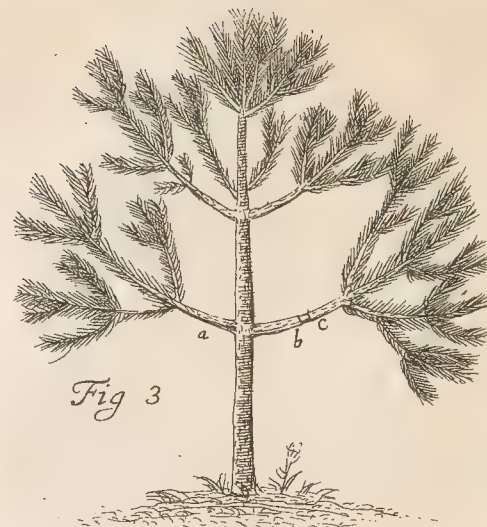


Fig. 3

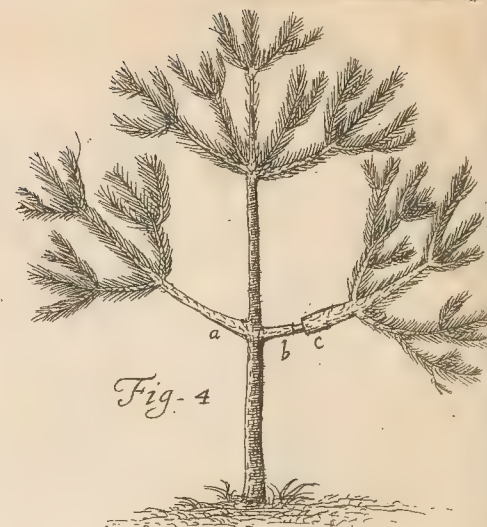


Fig. 4

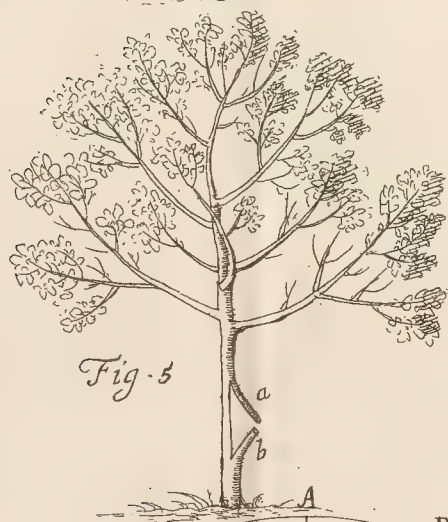


Fig. 5

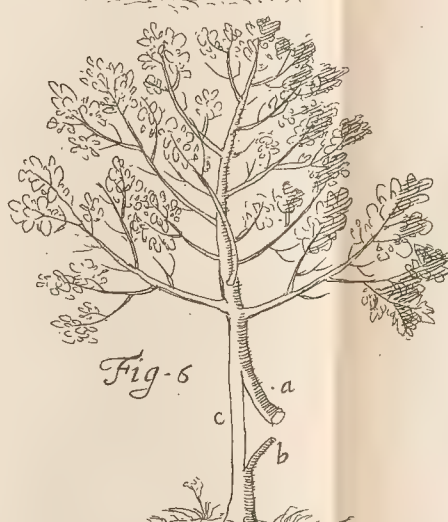


Fig. 6

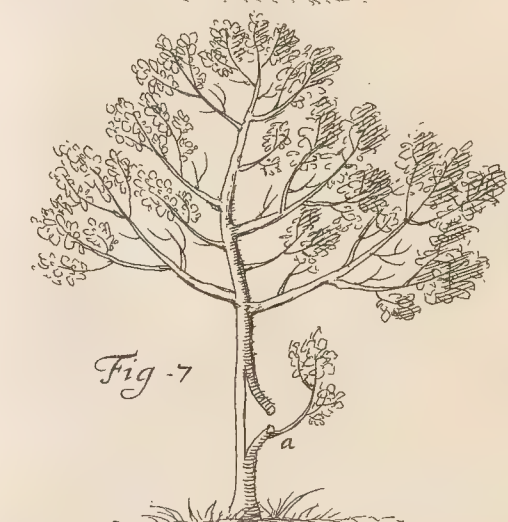


Fig. 7

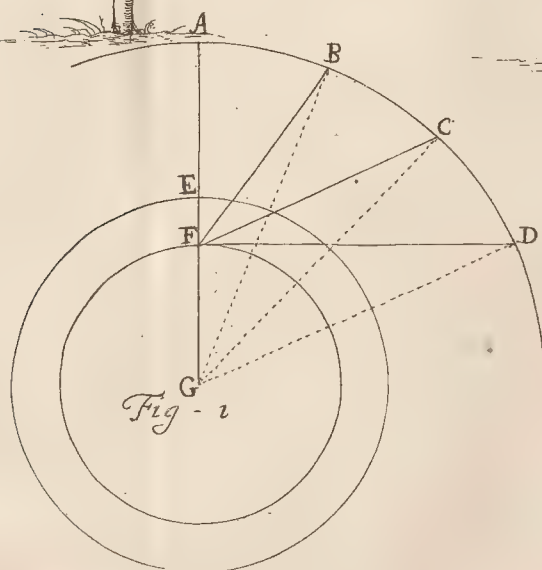


Fig. 1

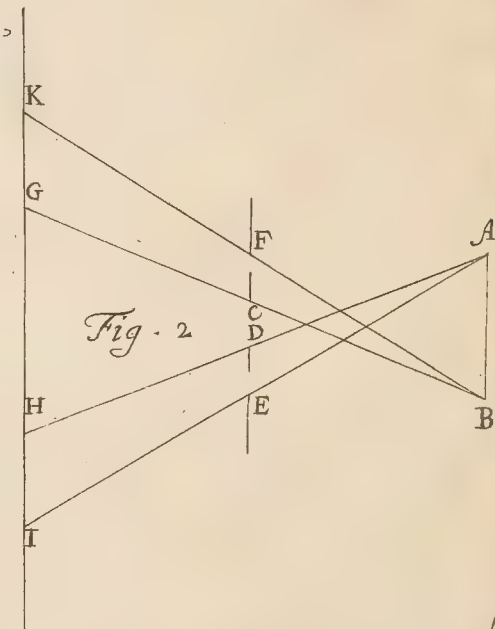


Fig. 2

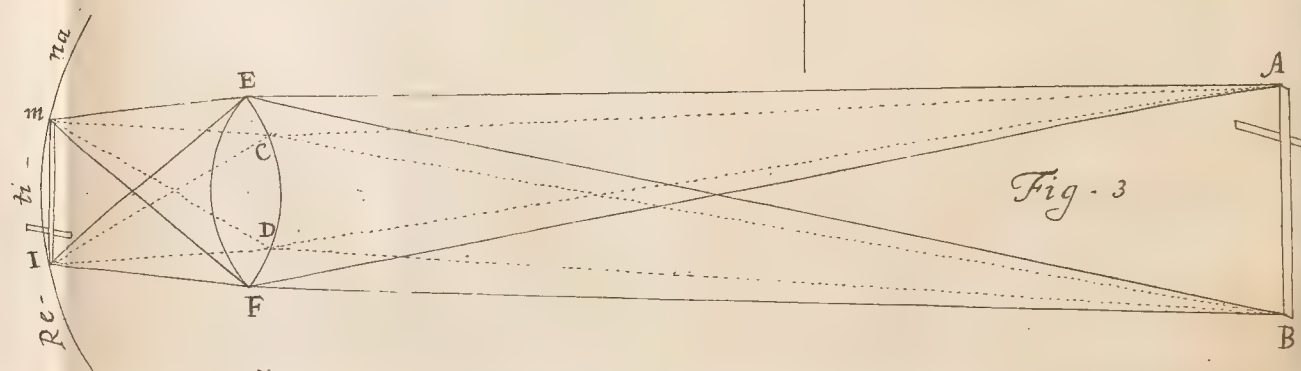


Fig. 3

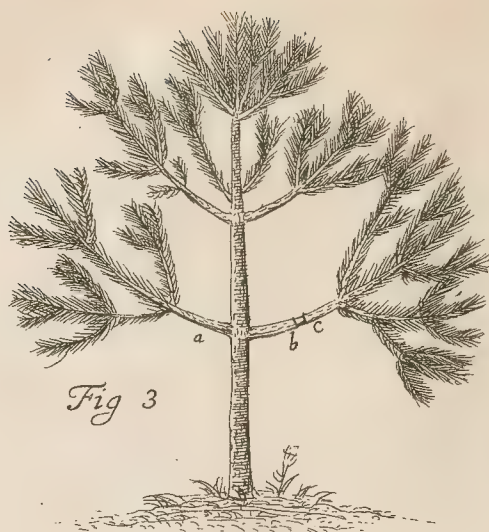


Fig 3

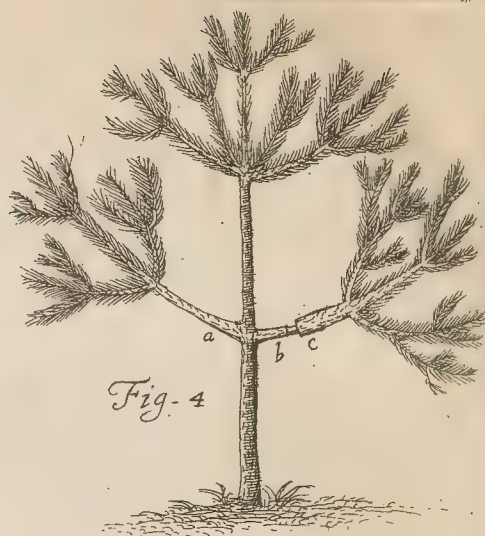


Fig-4



Fig-7

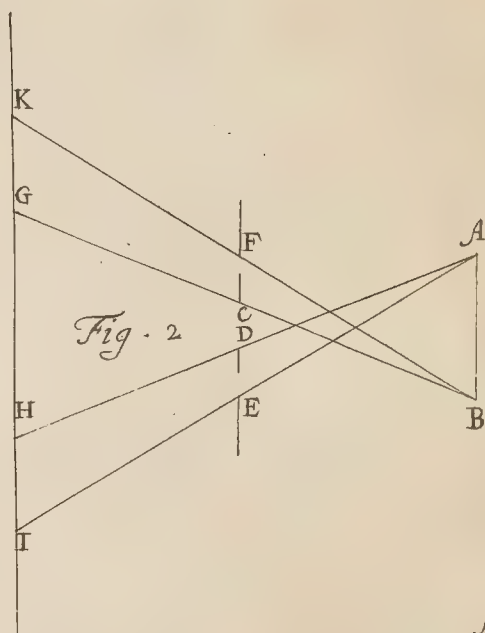


Fig-2

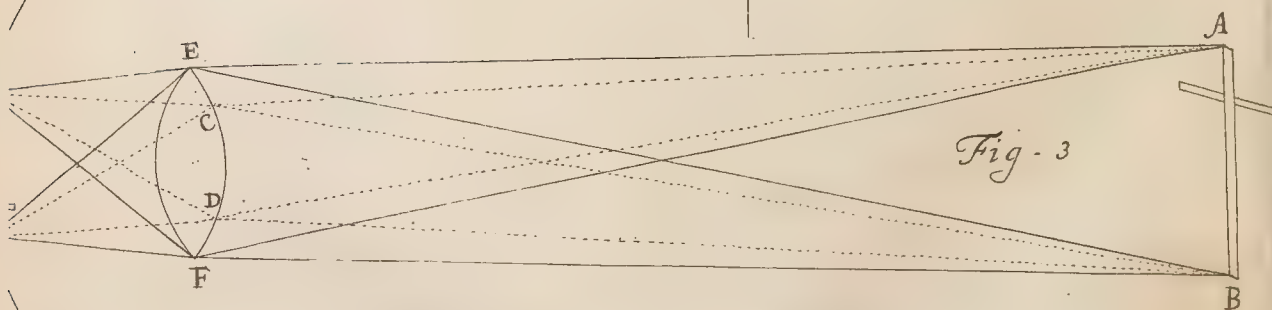


Fig-3

PHILOSOPHICAL

TRANSACTIONS

For the Months of *April, May and June* 1687.

The CONTENTS.

A Receipt to Cure Mad Doggs, or Men or Beasts Bitten by Mad Doggs. Communicated to the R. Society by Mr. Rob. Gourdon Knt. R. S. Soc. by his Majesties Command. (2.) A Letter of Monsieur Cassini to the Publisher, giving his Corrections of the Theory of the five Satellites of Saturn: With Tables of the Motions of those Satellites, adapted to the Meridian of London and the Julian Account. (3) An Account of several curious Observations and Experiments concerning the growth of Trees; made by Thomas Brotherton of Hey in the County of Lancaster Esq. Brought in and Read before the R. Society, by Mr. Robert Hook Fellow of the said Society. (4) A Discourse concerning the Apparent Magnitude of the Sun and Moon; or the Apparent Distance of 2 Starrs when nigh the Horizon, and when higher elevated; by William Molineux of Dublin Esq. Reg. Soc, Socius. (5.) The Sentiments of the Reverend and Learned Dr. John Wallis R. S. Soc. upon the aforesaid Appearence. Communicated in Letter to the Publisher. Account of a Book. A Continuation of the New Digester of Bones: Its Improvements and new Uses, hath applyed to, both at Sea and Land: Together with some improvements and new Uses of the Air Pump, tryed both in England and Italy. By D. Papin M. D. & R. S. Soc.

A Receipt to cure Mad Dogs; or Men or Beasts bitten by Mad Dogs: Communicated to the Royal Society, by Sr. Robt. Gourdon. By His MAJESTIES Command.

℞ **A** Grimony Roots, Primrose Roots, Dragon Roots Single Peony Roots, the Leaves of Box, of each a Handful; the *Starr of the Earth* two Handfuls; the black of *Crabs Claws* prepared, *Venice Treacle*, of each one Ounce; all these are to be beaten and bruised together, and boyled in about a Gallon of *Milk*, till the hal be boyled away; then put it into a Bottle, unstrained and give of it, about 3 or 4 Spoon-fuls at a time, to the *Dog or Beast*, three Mornings together before new and full *Moon*.

Observe, that it will be necessary the day before you administer the Medicine, to take away a little Blood.

Some of these Roots and Herbs, being difficult to be gotten in the Winter, they may be gathered in their Season, and being dried, and well powdered, may be given mixt with the *Crabs Claws*, and *Venice Treacle*, with *Sallet Oyl* or *Butter*, and it will do as well.

If it be for Men or Women that are bitten with *Mad Dogs*; take the same Ingredients in the same Quantities and the Roots and Herbs being bruised altogether, with the *Crabs Claws* and *Venice Treacle*; let them be infused warm in two Quarts of strong *White Wine*, for at least 12 Hours. This being strained, the Party bitten is to take about a quarter of a Pint Evening and Morning, three Days before the new and full *Moon*; it may be sweetned either with Sugar or some Cordial Syrup.

N B. The Plant in this Receipt called, *Starr of the Earth* and which is the chief Ingredient, is known among the Botanists, by the Name of *Sesamoides Salamantica*, *Parkinsoni*, five *Lychnis viscosa flore muscosa*, *Casp. Bauhini*. Anglic *Spanish Catch-flie*. It grows plentifully about *Thetford*, and about the Mill near *New Market*. Vide *Raii Catalogum Plantarum Anglo-Hispan. Plant. Tom. II. inter Lychnide*.

A Letter of Monsieur *Cassini* to the Publisher, giving his Corrections of the Theory of the five Satellites of Saturn; With Tables of the Motions of those Satellites, adapted to the Meri- dian of London, and the Julian Account.

CE que j'ay escrit jusqu' a present sur les nouvelles decouvertes, que j'ay faites depuis quelque temps dans le Ciel, est si peu de chose, que je ne l'ay pas jugé digne d' estre présenté a la Société Royale.

Je n' eus pas plus tost donné au Journal la decouverte des deux nouveaux Satellites de Saturne, que je vis qu'il y avoit quelque chose a elaircir, touchant leur distances, & la durée de leur conjonctions.

La distance du premier Satellite au centre de Saturne m' a paru variable, & son mouvement sensiblement inegal, plus vifte, en ce temps, dans le demicerle occidental, que dans l'oriental. J'ay dernièrement déterminé sa moyenne distance de $\frac{3}{4}$ du diametre de l'anneau de Saturne, son mouvement journalier de 6 fig. 10 d. 41'. 31". Ainsi si son mouvement estoit egal, la duree de sa conjonction avec Saturne, c'est a dire, tout le temps qu'il met a parcourir son anneau, seroit de 7 h. 46'. Elle m'a paru plus grande par les observations immediates, mais il est a remarquer que je n'ay jusqu' a present pu voir ce Satellite plus pres de Saturne, que d'un Quart d'un Anse.

J'ay calculé l'Epoque de son mouvement, pour le dernier Decembre 1685. a midi au meridiem de Paris en v° 24 d. 50'.

La distance du second Satellite du centre de Saturne m' a paru plus uniforme. Je l'ay déterminée d'un diametre de l'anneau & $\frac{1}{4}$. Son mouvement paroît aussi plus egal. J'ay calculé le journalier de 4 fig. 11 d. 31'. 30". Ainsi la durée de sa conjonction deuroit estre de 8 h. 36'. Je n'ay pas non plus vu jusqu' a present ce Satellite plus proche de l'anneau de Saturne que d' $\frac{1}{4}$ d'un anse. Comme ce Satellite se voioit la plus part du temps dedans les confins de la distance du Premier, au quel il est egal en grandeur, & semblable dans la couleur, la difficulté de distinguer l'un de l'autre a esté extreme, de sort que sans une assiduité particuliere aux observations, & sans une grande multitude de combinaisons je n'en serois pas venu a bout.

P p

J'ay

J'ay déterminé l'Epoque de ce Satellite pour le 31 Decembre 1685. à midi. en $\text{M} 9^{\text{d}}. 10'$.

La distance du Troisième du centre de Saturne paroît d' un diametre de l' anneau $\frac{3}{4}$. Son mouvement journalier 2 lig. 18. d. 41'. 50". Ainsi sa conjonction doit durer 10 heures. L'époque de son mouvement pour le midi du dernier de l'année 1685. $\text{M} 9^{\text{d}}. 39'$.

La distance du Quatrième Satellite au centre de Saturne paroît de 4 diametres de l'anneau. Son mouvement journalier de 22 d. 34'. 38", la duree de sa conjonction 15 h. 6'. L'époque de son mouvement au mesme temps & lieu que les autres en $\text{K} 18^{\text{d}}. 1'$.

La distance du cinquième Satellite au centre de Saturne de 12 diametres de l'anneau. Son mouvement journalier de 4 d. 32'. 17". Ses conjonctions durent 24 heures. L'époque de son mouvement au mesme temps & lieu en $\text{K} 16. 19$. Sur ces principes on peut construire les Tables, & les Ephemerides.

Voicy, Monsieur, en deux pages le resultat d'un Travail tres long & tres penible, que je vous prie de communiquer a la Societé Royale, la suppliant de l'agreer, & d'attribuer au persond respect, que je luy dois, la reserve que j'ay eüe de ne luy presenter que des choses bien digerées, &c.

Paris, le 10. Octobre,
1686.

Cassini

FOR the sake of the Curious in Astronomical Matters, and to help them to know where to look for these obscure little Stars, it was thought fit to deduce from the Elements delivered in this Letter, the following Tables, serving to compute easily their Places at any time assigned.

Tabula

*Tabula Motus Medii Intimi Satellitis
Saturni, à Cassino Detecti Anno 1686.*

Ann. Chrif. Curr.	Epochæ o. ' "	Annus	Mot. Med. s. o. ' "	Diebus	Mot. Med. s. o. ' "	H. M.	Mot. Med. sex. ° ' "	Motus Medi. ° ' "
1681	19.34	1	4. 2.34	1	6.10.42	1	0. 7.57	31 4. 6
1685	10.30	2	8. 5. 7	2	0.21.23	2	0.15.53	32 4. 14
1686	13. 4	3	0. 7.41	3	7. 2. 5	3	0.23.50	33 4. 22
1687	15.37	4	10.20.56	4	1.12.46	4	0.31.47	34 4. 30
1688	18.11	5	2.23.30	5	7.23.28	5	0.39.44	35 4. 38
1689	1.26	6	6.26.04	6	2.04.09	6	0. 7.40	36 4. 46
1701	4.14	7	10.28.38	7	8.14.50	7	0.55.37	37 4. 54
Menf. Anni Com.	Mot. Med. s. o. ' "	8	9.11.52	8	2.25.32	8	1.03.34	38 5. 2
		9	1.14.26	9	9.06.14	9	1.11.31	39 5. 10
		10	5.17.00	10	3.16.53	10	1.19.28	40 5. 18
Jan.	0. 0. 0	11	9.19.34	11	9.27.36	11	1.27.24	41 5. 26
Febr.	5. 1.27	12	8. 2.48	12	4. 8.18	12	1.35.21	42 5. 34
Mar.	3. 0.49	13	0. 5.22	13	10.19.00	13	1.43.18	43 5. 42
Apr.	8.02.16	14	4. 7.56	14	4.29.41	14	1.51.15	44 5. 50
Maii	6.23.02	15	8.10.29	15	11.10.23	15	1.59.11	45 5. 58
Junii	11.24.29	16	6.23.43	16	5.21.04	16	2. 7. 8	46 6. 5
Julii	10.15.15	17	10.26.17	17	0.01.46	17	2.15.05	47 6. 13
Aug.	3.16.42	18	2.28.51	18	6.12.28	18	2.23.01	48 6. 21
Sept.	8.18.09	19	7. 1.25	19	0.23.09	19	2.30.58	49 6. 29
Octo.	7.08.54	20	5.14.39	20	7. 3.50	20	2.38.55	50 6. 37
Nov.	0.10.21			21	1.14.32	21	2.46.52	51 6. 45
Dec.	11.01.07			22	7.25.13	22	2.54.49	52 6. 53
				23	2.05.55	23	3. 2.45	53 7. 1
				24	8.16.36	24	3.10.42	54 7. 9
				25	2.27.18	25	3.18.39	55 7. 17
				26	9.07.59	26	3.26.35	56 7. 25
				27	3.18.41	27	3.34.32	57 7. 33
				28	9.29.22	28	3.42.28	58 7. 41
				29	4.10.03	29	3.50.25	59 7. 49
				30	10.20.45	30	3.58.22	60 7. 57

*In Anno Bissextili post Fe-
bruariam adde unum di-
em motumque ei compe-
tentem.*

*Tabula Motus Medii penintimi Satellitis
Saturni, à Cassino Detecti Anno 1686.*

<i>Ann. Chris. Curr.</i>	<i>Epochæ o. ' .</i>	<i>Annus</i>	<i>Mot. Med. s. o. ' .</i>	<i>Diebus</i>	<i>Mot. Med. s. o. ' .</i>	<i>H. sex. ° ' . M. ° ' .</i>	<i>Mot. Med. M. ° ' .</i>	<i>Motus Medi. M. ° ' .</i>
1681	✕. 20. 41	1	4. 6. 37	1	4. 11. 31	1 0. 5. 29	31 2. 50	
1685	†. 28. 42	2	8. 13. 15	2	8. 23. 03	2 0. 10. 58	32 2. 56	
1686	8. 5. 20	3	0. 19. 52	3	1. 4. 34	3 0. 16. 26	33 3. 01	
1687	℞. 11. 57	4	9. 8. 1	4	5. 16. 06	4 0. 21. 55	34 3. 7	
1688	∞. 18. 35	5	1. 14. 39	5	9. 27. 37	5 0. 27. 24	35 3. 12	
1689	∞. 6. 44	6	5. 21. 16	6	2. 09. 09	6 0. 32. 53	36 3. 17	
1701	∞. 0. 48	7	9. 27. 54	7	6. 20. 40	7 0. 38. 22	37 3. 23	
		8	6. 16. 3	8	11. 2. 12	8 0. 43. 51	38 3. 28	
<i>Menf. Anni Com</i>	<i>Mot. Med. s. o. ' .</i>	9	10. 22. 40	9	3. 13. 43	9 0. 49. 19	39 3. 34	
		10	2. 29. 18	10	7. 25. 15	10 0. 54. 48	40 3. 40	
<i>Jan.</i>	0. 0. 0	11	7 05. 55	11	0. 06. 46	11 1. 00. 17	41 3. 45	
<i>Febr.</i>	3. 27. 16	12	3. 24. 04	12	4. 18. 18	12 1. 5. 46	42 3. 50	
<i>Mar.</i>	6. 19. 38	13	8. 00. 42	13	8. 29. 49	13 1. 11. 15	43 3. 56	
<i>Apri.</i>	10. 17. 15	14	0. 07. 19	14	1. 11. 21	14 1. 16. 44	44 4. 01	
<i>Maii</i>	10. 3. 0	15	4. 13. 57	15	5. 22. 52	15 1. 22. 12	45 4. 7	
<i>Junii</i>	2. 0. 16	16	1. 02. 06	16	10. 04. 24	16 1. 27. 42	46 4. 12	
<i>Julii</i>	1. 16. 1	17	5. 08. 43	17	2. 15. 55	17 1. 33. 11	47 4. 17	
<i>Aug.</i>	5. 13. 18	18	9. 15. 21	18	6. 27. 27	18 1. 38. 39	48 4. 23	
<i>Sept.</i>	9. 10. 34	19	1. 21. 58	19	11. 08. 38	19 1. 44. 08	49 4. 28	
<i>Octo.</i>	8. 26. 19	20	10. 10. 07	20	3. 20. 30	20 1. 49. 37	50 4. 34	
<i>Nov.</i>	0. 23. 36			21	8. 2. 1	21 1. 55. 06	51 4. 39	
<i>Dec.</i>	0. 9. 21			22	0. 13. 33	22 2. 00. 34	52 4. 45	
				23	4. 25. 4	23 2. 6. 03	53 4. 50	
				24	9. 06. 36	24 2. 11. 31	54 4. 56	
				25	1. 18. 07	25 2. 17. 00	55 5. 01	
				26	5. 29. 39	26 2. 22. 29	56 5. 7	
				27	10. 11. 10	27 2. 27. 58	57 5. 12	
				28	2. 22. 42	28 2. 33. 26	58 5. 18	
				29	7. 04. 13	29 2. 38. 55	59 5. 23	
				30	11. 15. 45	30 2. 44. 24	60 5. 29	

In Anno Bissextili post Februarium adde unum diem motumque ei competentem.

Tabula Motus Medii Satellitis Saturnii
Medii, à Cassino detecti Anno 1673.

<i>Ann.</i> <i>Chrif.</i> <i>Curr.</i>	<i>Epochæ</i> o. ' "	<i>Ann.</i> s. o. ' "	<i>Mot. Med.</i> s. o. ' "	<i>Diebus</i>	<i>Mot. Med.</i> s. o. ' "	<i>H.</i> M.	<i>Mot. Me.</i> sex. °. ' " M.	<i>Motus</i> <i>Med.</i> o. ' "
1661	22.50	1	9.14.29	1	2.18.42	1	0.3.17.31	1. 41
1681	16. 3	2	6.28.58	2	5. 7.24	2	0.6.33.32	1. 45
1685	2.41	3	4.13.27	3	7.26.05	3	0.9.50.33	1. 48
1686	17.10	4	4.16.38	4	10.14.47	4	0.13. 7.34	1. 52
1687	1.39	5	2.01.08	5	1. 3.29	5	0.16.24.35	1. 55
1688	16. 9	6	11.15.37	6	3.22.11	6	0.19.40.36	1. 58
1689	19.20	7	9.00.06	7	6.10.53	7	0.22.57.37	2. 1
1701	9.15	8	9. 3.17	8	8.29.35	8	0.26.14.38	2. 5
<i>Mens.</i> <i>Anni</i> <i>Com.</i>	<i>Mot. Med.</i> s. o. ' "	9	6.17.46	9	11.18.16	9	0.29.31.39	2. 8
		10	4.02.15	10	2. 6.58	10	0.32.47.40	2. 11
<i>Jan.</i>	0. 0. 0	11	1.16.45	11	4.25.40	11	0.36.04.41	2. 14
<i>Febr.</i>	9. 9.37	12	1.19.55	12	7.14.22	12	0.39.21.42	2. 18
<i>Mar.</i>	10.23. 8	13	11.04.24	13	10.03.04	13	0.42.38.43	2. 21
<i>Apri.</i>	8. 2.45	14	8.18.54	14	0.21.46	14	0.45.55.44	2. 24
		15	6.03.23	15	3.10.27	15	0.49.11.45	2. 28
<i>Maii</i>	2.23.40	16	6. 6.34	16	5.29.09	16	0.52.28.46	2. 31
<i>Junii</i>	0. 3.17	17	3.21.03	17	8.17.51	17	0.55.45.47	2. 34
<i>Julii</i>	6.24.12	18	1.05.32	18	11.06.33	18	0.59. 1.48	2. 37
<i>Aug.</i>	4. 3.49	19	10.20.01	19	1.25.15	19	1.02.18.49	2. 40
<i>Sept.</i>	1.13.25	20	10.23.12	20	4.13.57	20	1. 5.35.50	2. 44
<i>Octo.</i>	8. 4.20			21	7.02.39	21	1. 8.52.51	2. 47
<i>Nov</i>	5.13.57			22	9.21.20	22	1.12.08.52	2. 50
<i>Dece.</i>	0. 4.52			23	0.10.02	23	1.15.25.53	2. 54
				24	2.28.44	24	1.18.42.54	2. 57
				25	5.17.26	25	1.21.59.55	3. 00
				26	8.06.08	26	1.25.15.56	3. 4
				27	10.24.50	27	1.28.32.57	3. 7
				28	1.13.32	28	1.31.49.58	3. 10
				29	4.02.13	29	1.35.06.59	3. 13
				30	6.20.55	30	1.38.22.60	3. 17

In Anno Bissextili post Februarium adde unum diem, motumque competentem.

*Tabula Motus Medii penextimi Satellitis
Saturni, ab Hugenio inventi Anno 1655.*

<i>Ann. Chrif. Curr.</i>	<i>Epochæ s. o. '</i>	<i>Annus</i>	<i>Mot. Med. s. o. '</i>	<i>Diebus</i>	<i>Mot. Med. s. o. '</i>	<i>H. M.</i>	<i>Mot. Me. o. ' " M.</i>	<i>Motus Med. ' "</i>
1641	W. 24.43	1	10.20.41	1	0.22.35	1	0. 56 31	29.10
1661	X. 11.19	2	9.11.22	2	1.15. 9	2	1. 53 32	30. 6
1681	V. 27.56	3	8.02.03	3	2. 7.44	3	2. 49 33	31. 3
1685	F. 13.15	4	7.15.19	4	3. 0.18	4	3. 46 34	31.59
1686	m. 3.56	5	6. 6.00	5	3.22.53	5	4. 42 35	32.55
1687	W. 24.37	6	4.26.41	6	4.15.28	6	5. 39 36	33.52
1688	Ω. 15.19	7	3.17.22	7	5. 8. 2	7	6. 35 37	34.48
1689	Ξ. 28.34	8	3.00.39	8	6. 0.37	8	7. 32 38	35.45
1701	Π. 14.32	9	1.21.20	9	6.23.12	9	8. 28 39	36.41
<i>Mens. Anni Com.</i>	<i>Mot. Med. s. o. '</i>	10	0.12. 1	10	7.15.46	10	9. 24 40	37.38
<i>Jan.</i>	0. 0. 0	11	11. 2.42	11	8. 8.21	11	10. 21 41	38.34
<i>Febr.</i>	11. 9.54	12	10.15.58	12	9. 0.55	12	11. 17 42	39.31
<i>Mar.</i>	8.12. 3	13	9.06.39	13	9.23.30	13	12. 14 43	40.27
<i>Apr.</i>	7.21.57	14	7.27.20	14	10.16. 5	14	13. 10 44	41.24
<i>Maii</i>	6. 9.16	15	6.18.01	15	11. 8.39	15	14. 7 45	42.20
<i>Junii</i>	5.19.10	16	6. 1.17	16	0. 1.14	16	15. 3 46	43.17
<i>Julii</i>	4. 6.29	17	4.21.58	17	0.23.48	17	16. 0 47	44.13
<i>Aug.</i>	3.16.22	18	3.12.40	18	1.16.23	18	16. 56 48	45.10
<i>Sept.</i>	2.26.16	19	2. 3.21	19	2. 8.58	19	17. 52 49	46. 6
<i>Octo.</i>	1.13.35	20	1.16.36	20	3. 1.32	20	18. 49 50	47. 3
<i>Nov.</i>	0.23.29	21		21	3.24. 7	21	19. 45 51	47.59
<i>Dece.</i>	11.10.48	22		22	4.16.42	22	20. 42 52	48.56
		23		23	5. 9.16	23	21. 38 53	49.52
		24		24	6. 1.51	24	22. 35 54	50.49
		25		25	6.24.25	25	23. 3 55	51.45
<i>In Anno Bissextili post Fe- bruarium adde unum di- em, motumque competen- tem.</i>				26	7.17.00	26	24. 27 56	52.42
				27	8. 9.35	27	25. 24 57	53.38
				28	9. 2. 9	28	26. 20 58	54.35
				29	9.24.44	29	27. 17 59	55.31
				30	10.17.18	30	28. 13 60	56.27

Tabula Mediorum Motuum Extimi Satellitis Saturnii, à Cassino detecti Anno 1671.

<i>Annis Chrif. Curr.</i>	<i>Epochæ s. o. '.</i>	<i>Annus</i>	<i>Mot. Med. s. o. '.</i>	<i>Diebus</i>	<i>Mot. Med. s. o. '.</i>	<i>H. M.</i>	<i>M.M ° ' " M.</i>	<i>Motus Med. '.</i>
1661	☿. 24.45	1	7. 6.23	1	0. 4.32	1	0.11 31	5.51
1681	Υ. 25.15	2	2.12.47	2	0. 9. 5	2	0.23 32	6. 3
1685	♊. 25.21	3	9.19.10	3	0.13.37	3	0.34 33	6.14
1686	♋. 1.44	4	5.00.06	4	0.18. 9	4	0.45 34	6.25
1687	♌. 8. 7	5	0. 6.29	5	0.22.41	5	0.57 35	6.37
1688	♍. 14.31	6	7.12.53	6	0.27.14	6	1. 8 36	6.48
1689	♎. 25.27	7	2.19.16	7	1.01.46	7	1.19 37	7.00
1701	♏. 25.45	8	10. 0.12	8	1. 6.18	8	1.31 38	7.11
<i>Men- fibus.</i>	<i>Mot. Med. s. o. '.</i>	9	5. 6.35	9	1.10.50	9	1.42 39	7.22
		10	0.12.59	10	1.15.23	10	1.53 40	7.34
<i>Jan.</i>	0. 0. 0	11	7.19.22	11	1.19.55	11	2. 5 41	7.45
<i>Febr.</i>	4.20.41	12	3. 0.18	12	1.24.27	12	2.16 42	7.56
<i>Mar.</i>	8.27.45	13	10. 6.41	13	1.28.59	13	2.27 43	8. 8
<i>Apri.</i>	1.18.25	14	5.13.05	14	2. 3.32	14	2.39 44	8.19
<i>Maii</i>	6. 4.34	15	0.19.28	15	2. 8.04	15	2.50 45	8.30
<i>Junii</i>	10.25.15	16	8. 0.24	16	2.12.36	16	3. 1 46	8.42
<i>Julii.</i>	3.11.23	17	3. 6.47	17	2.17.08	17	3.13 47	8.53
<i>Aug.</i>	8. 2. 4	18	10.13.11	18	2.21.41	18	3.24 48	9. 4
<i>Sept.</i>	0.22.45	19	5.19.34	19	2.26.13	19	3.35 49	9.16
<i>Octo.</i>	5. 8.53	20	1. 0.20	20	3. 0.46	20	3.47 50	9.27
<i>Nov.</i>	9.29.34			21	3. 5.18	21	3.58 51	9.38
<i>Dec.</i>	2.15.43			22	3. 9.50	22	4. 9 52	9.50
				23	3.14.22	23	4.21 53	10.01
				24	3.18.54	24	4.32 54	10.12
				25	3.23.27	25	4.43 55	10.24
				26	3.27.59	26	4.55 56	10.35
				27	4.02.31	27	5. 6 57	10.46
				28	4. 7.04	28	5.17 58	10.58
				29	4.11.36	29	5.29 59	11. 9
				30	4.16. 8	30	5.40 60	11.21

*In Anno Bissextili post
Februarium adde unum
diem, motumque com-
petentem.*

AS to the Use of these Tables, it is supposed that the Reader is so much versed in Astronomical Calculation, as to know how to compute by them, they being in the usual Form; if not, there is sufficient direction given in the Correction of *Hugens's* Satellite, to be found in Numb. 145. of these Transactions. I shall only add, That the Proportion of the Squares of the times of the Periods, to the Cubes of the Distances, (which is proposed as probable by *Kepler*, but now demonstratively found true by *Mr. Newton*,) gives us nicely the Proportion of the Distances of these Planets from the Center of *Saturn*; and supposing the Satellite of *Hugens* four Diameters of *Saturn's* Ring distant from him, we shall find by the Periods, the Distances, as follows.

	Periodus.			Distantia.
	d.	h.		
Intimi	1	21	$18\frac{1}{2}$ —	0, 964
Penintimi	2	17	$41\frac{1}{2}$ —	1, 235
Medii	4	13	$47\frac{1}{4}$ —	1, 740
Penextimi	15	22	41 —	4, 000
Extimi	79	7	54 —	11, 621

These Distances may be used, as more accurate than those obtained by Observation, which yet differ but little therefrom. The outermost Satellite being so far distant, cannot fail of being seen every greatest Elongation. This present Year 1687, it will be in its greatest occidental distance July 24. again Octob. 12. and Jan. 2. 1688. and on the Oriental Side on Sept. 3. 1687. Nov. 23. and about the middle of Feb. 1688. at which Times all those that are furnished with good Telescopes may satisfy themselves of the Truth of these Discoveries.

Those that desire a fuller Account of this Matter, may find it in N. 92. N. 145. N. 181. of these Transactions.

An Account of several curious Observations and Experiments, concerning the Growth of Trees ; made by Thomas Brotherton, of Hey, in the County of Lancaster, Esq. Brought in and Read before the R. S. by R.H. Fellow of the said Society.

The Experiments and Observations, were made at Hey, in the County of Lancaster.

THe first Experiment was made in the Year 1671, upon a *Crab Tree*, about four Inches in Diameter ; it was hacked round with a Hatchet, so as to cut pretty deep into the Wood, besides the cutting off of the Bark, for about four Inches wide. After which it was the same Year observed to increase above the said hacking very considerably, and to shoot in length of Wood, about one Foot ; the next Year it increased considerably, and shot in length about nine Inches : But the third Year it dyed to the very Root.

Much the like was observed in another, part of whose Bark was eaten off by a Canker, that the lower part stood, without increasing, and by degrees the Wood rotted and mortified ; but the upper part increased to the 3d. year when it Dyed also.

Most of the following Experiments, were tryed on the *Abies* or *Scotch-Firr*, and on the black *Poplar* with white Bark, and on *Hazel* and *Asb* Trees.

A *Scotch-Firr* of three Years growth, having a Ring of the Bark cut off, of the breadth of three Inches, near the bottom of the Stem or Stalk, below the upermost Knot or Joynt, was observed to grow and shoot out its Top, about

half a Yard ; and the Parts all about the Ring, to increase very much in thickness the same Year the Section was made, and to increase in thickness, much more than it would have done if the Section had not been made: but all that part of the Stock, between the the said Ring and the Knot next below it, increased not at all ; but that part which was below the next Knot increased somewhat, yet not so much as if the said Ring of the Bark, had not been cut off. The 2^d. Year it also increased considerably, but not so much as the first ; but, the third Year it died. The Branch that was here produced, had the Ring cut off from it, *Apr.* the 1st. 1686, and the part above the Section increased, and grew till the 17th. of *October* following, when it was cut off from the Tree. In this space of time the part below the Ring increased not at all, but stood at a stay; but the part about the Ring shot out a new Joynt, between a Foot and half a Yard, and increased in thickness for the whole length of it, and in all its parts twice as much as it would have done, if it had not been Cut, as was apparent by a like Branch on the opposite side of the Knot, which was not cut or barked round in the same manner: The Bark also of the part above the Section, swelled, or grew downwards over the woody part, (which was bare) above half an Inch in breadth.

The usual time for making this Section, was either in *March* or the beginning of *April*.

Tryal was made upon some young Trees cutting a helical swath of the Bark, a bout halfe an inch in breadth, by leaving a like helical swath of Bark to communicate between the upper and under part ; in this Tryal, the difference of growth succeeded not, but the remaining swath of the Bark swelled downwards, and by the end of the Year, covered the bared part of the Wood.

The like event almost followed, upon making an indented Section round, of about half an Inch in breadth ; the
uper

upper Bark quickly swelling downward, and joyning again with the lower.

It was also observable, that as the upper Bark grew downwards ; so it increased also in thickness, whereas the Bark below the Section thickned not at all.

Several of those Bows, which were about one Inch in Diameter, and had increased, as above the Summer before were observed to out live the great Frost, and to receive no considerable Damage ; whereas many others otherwise ordered, were killed by it, as will appear by and by, more particularly.

In the first *Fig.* is represented a *Scotch* Firr of three Years growth (it shooting forth every Year, both from the Body, and the Branches a new Joynt and circumambient Sprouts, to a determinate length) barked with three Rings, of about $1\frac{1}{2}$ Inch broad, each about the middle of the Internodia or parts of the Stock between the Joynts, at *c b*, & *a* ; this in one Year increased and shot forth branchings, as in the second *Fig.* that is the Stock at *a*, which was about the bigness of a Quill, below the Ring to the next Joynt continued of the same bigness, but above the Ring it increased and grew to the bigness of ones Finger, and from the new Joynt at *e* shot out new Limbs and Stock about a quarter of a Yard, which was somewhat bigger, than if there had been no Ring made. Next the Branches *f f* increased likewise proportionably, by swelling in bigness, and from a new Joynt shooting out new Body and Limbs, as the Top or Body ; and the Body of the Tree below the Joynt *b* to the Ring *b*, increased more than if the Ring had not been made ; but the part of the Stock below the Ring to the next Joynt, increased not at all. The like shooting forth and increasing, was observed in the 2^d. Limbs Joynt and Stock below it *g g. i* to *c*, between which and *k*, it increased not.

The like also succeeded in the lower Branches *l l*, and Joynt *k*, and in the Stock *d*, below the Joynt *k*.

Fig. the 3d. Represents a young *Scotch Firr* of two Years old, on one of the lowermost Branches *c*, was made a Ring Section between the Body and first Knot of the Limb. The following Year, that part of the Limb above the Ring, increased twice or thrice as much as the corresponding parts of the other Limbs, from the same Knot, as *a*, which increased as if there had been no Section made at *B*, but the part below *b* to the Body, increased not at all.

Fig. 5 represents a young *Hazel* cut into the Body with a deep gash, and the parts of the Body above and below cleft upwards and downwards, and the Splinters *a* and *b*, by wedges kept off from touching each other, or the rest of the Body. These the following Year were observed to be in the State represented in the *6th. Fig.* that is the Splinter *a* above the gash, was grown very much, but the Splinter *b* below, stood at a stay and grew not, but the rest of the Body at *c*, grew as if there had been no gash made.

Fig. 7 Represents a like gash made just above the lowermost Knot; and the parts splinter'd or cleft and wedged off from each other, and from the Body as before, but there is left a Branch upon the lower Splinter to see what will be the State thereof the next Year, or in *October* next. When 'tis probable by the other Experiments the lower Splinter and Branch upon it, will be found to have grown and increased as the Splinter in the former Experiment did above the gash, though not in the same Proportion.

Fig. 8 Represents four young *Poplar Trees*, *A, B, C D*, all of equal bigness, growth, situation, and soyl as near as could be found; these were ordered as is represented in the *9th. Fig.* that is *A* had all its branches and top cut off *B* had all its branches pruned off, but it was left with a small Head at the top. *C* had the branches cut about half way, and those of the uper half left growing. *D* was left grow-

growing without being at all pruned or lopped ; the event was expected.

The success was found to be thus *A* in the following Years shot out many Twigs round about, but the Body increased but little in height or bigness. *B* shot out likewise many Twigs where it had been pruned, and the top-branches and top also increased considerably, and the Body also increased much more in height and bigness than did the former *A*. *C* increased yet much more in all its parts than *B*. But *D* increased in Limbs, Height, and Bigness most of all; swelling in bigness, and stretching in height and spreading in its Boughs much more than *C*; and in about 10 Years, was more than four times as bigg as *A*.

The same worthy Person also observed, that all the *Poplars* that had been pruned, dyed in the great Frost 1684; in so much, that of 25 that were so ordered, he observed 19 of them to be killed by it, and the remaining to be very weak and hardly able to recover, and increased very little in the following Years. These *Poplars* were about 30 Foot high, and had only a small Head left at the top unloped, of about 4 or 5 Foot, and were pruned, the Spring before the great Frost. He observed also, that divers of those which had been pruned two Summers before the Frost, were killed by it: But none of those which had not been pruned at all, were hurt by it. He took Notice also, both in *Lancashire* and *Cheshire*, that Trees of 60 Foot in height, that had been pruned, and had only a small Top left, were also killed by the said Frost; whereas those Trees of the same Kind and Height, which stood near to them, but had not been pruned, continued to flourish, and suffered no harm thereby. Several of those Branches of about an Inch Diameter, and Trees that had been barked round, as above, the Spring before the great Frost, out lived the violence of the same, and the preceding Winter.

Where

Where these prunings had been tryed upon Trees 20 Foot high ; the difference of their Increase, was sensible the following Summer, but in 7 or 8 Years time, the difference is prodigious ; the un-pruned Trees growing several times bigger than the pruned, both in Body and Branches, even to Admiration.

He hath often observed, also that when the top Branches would shoot out and grow 2 Foot, or more, in length ; the lower Branches would not shoot above 4 Inches. And further, that in the Branches of the *Scotch Fir*, the Joynts above the Rings barked round, would increase and grow much bigger in 3 Years, than they would in 5 Years, if the said Rings were not cut off.

The same Person upon Discoursing some, other particular Inquiries about the Spreading and Increase of the Roots, assured me, that he had observed a very large *Pinaster* about two Foot and an half in Diameter, and of a heighth proportionable (*viz:* of about 20 Yards ; the lowest Boughs of which, were about 30 Foot above the Ground) did spread and flourish on every side a like, though it had no Root at all towards three quarters of its Situation, but only toward one quarter, into which it spread its Roots very farr and large, divers of them reaching about 70 or 80 Foot from the Body of the Tree : The Reason of which spreading was occasioned by its being planted just within the square Angle of the Corner of a deep thick and strong Stone Wall, which was a kind of Bauking or Wharfing against a River that ran by it : This Tree I say, tho' it had nourishment only from one quarter of four to its Roots, yet did the same flourish and spread equally on every side.

Upon Consideration of these and divers other Observations, and Experiments Mr. *Brotherton* is of Opinion.
1 That the Sap (most of it if not all) ascends in the Vessels of the lignous part of the Tree, and not in the Cortical Part, nor between the Cortical and Lignous parts.

2. That

2. That the Increase and Growth of a Tree in thickness is by the descent of the Sap, and not by the ascent; and if there were no descent, a Tree would Increase but very little, if at all.

3. That there is a continual Circulation of the Sap all the Summer Season, and during such time as the Sap is stirring, and not a Descent at *Michaelmas*, only as some have held.

To me it seems very probable, that the Bodies of Plants, as well as those of moving Animals, are nourisht and increased by a double Food; the one an impregnated Water, and the other an impregnated Air, and that without a convenient supply of these two, the Vegetable cannot subsist, at least not increase. These do mutually mix and coalesce, and parts of the Air convert to Water, and parts of Water convert to Air. As some of this latter are rarified and freed from their Chains and become Spiritual and Aairy, so others of the fore-mentioned, are clogge'd and fettered and become debased. To this purpose all Plants as well as Animals, have a twofold kind of Roots, one that branches and spreads into the Earth, and another that spreads and shoots into the Air, both Kinds of Roots serve to receive and carry their proper Nourishment to the Body of the Plant, and both serve also to convey and carry off the useless Recrements; useless I mean any further within the Body of the Plant, though useful to it when they are separated, and without it, the one for Seasoning the Earth and Water wherein it is planted, and the other for seasoning and preparing the Air, the Method of which I have els where explained.

Concerning the Apparent Magnitude of the Sun and Moon, or the Apparent Distance of two Stars, when nigh the Horizon, and when Higher elevated.

I Do not Designe so much to establish any thing of my own that may be satisfactory in solving this admirable appearance, as to detect the Errors of those that have offered at a solution thereof, and have come short (as I conceive) of being satisfactory; that thereby I may again sett the minds of Philosophers on Work, and rouse them up to enquire a new after this surprising *Phænomenon*. That I may doe this the more Effectually, I shall briefly declare the Matter of Fact and then proceed to the Reason thereof, given by several, and to their Confutations.

First therefore it is well known that the mean apparent Magnitude of the Moon is 30 *m.* 30 *f.* we will take it *Numero Rotundo* to be 30, that is, an Arch of a great Circle in the Heavens of 30 Minuts is covered by her Diameter, and this we'll suppose to be her apparent Diameter, at a full Moon in the midst of Winter, and when she's in the Meridian, and at her greatest Northern Latitude and Consequently the utmost that she can be elevated in our *Horizon*; tis as well known also that when she is in this Posture, being Looked upon by the Naked Eye she appears (that we may accomodate all to sensible Measures) to be *Magnitudinis Pedalis*, about a foot broad. But the same Moon being Looked upon just as she rises, she appears to be three or four foot broad, and yet if with
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an Instrument we take her Diameter, both in one posture and t'other, we shall find that still she shall be but 30 Minutes; the several ways of trying this I will not Mention, they being as Various as are the Methods of taking the Moons apparent Diameter, common enough amongst the *Astronomers*; neither will I insist upon the truth of the Matter of Fact, for that I think cannot reasonably be questioned, after so many tryals and so many experiments thereof, faithfully recorded by undoubted witnesses; and it would be very unreasonable to Imagine that so many Authors should rack their Brains for solving an appearance, wherein they were not certain of the matter of Fact. But because of *Nullius in Verba*, I can assert that I have accurately tryed it my selfe, and I have so found it: one of the ways I proceeded was thus, I took a very good *Telescope* of about 6 foot long, in the inward *Focus* of whose Eye-Glass I apply'd a very fine Lattice made of the single hairs of a Mans Head; then Looking with this at the Moon when she was just Risen and Looked Extraordinarily big, I observed what Number of the squares of the Lattice were Occupy'd by her body; then observing her again, when more Elevated and free from all Extravagant greatness, I still found the same squares of the Lattice possessed by her. This way is Equivalent to that now more used, of taking her Diameter by Mr. *Townlys Micro-meters*: but I have also tryed and found the same thing by an Accurate Sextant, taking the distance of the Moons Opposite Limbs.

Now this *Phænomenon* affords two things to be considered, first why the Moon (I still name the Moon as being an Object more adapted for our sight, for the same thing holds in the Sun) should seem bigger about the *Horizon*, then when more elevated; and secondly, shee appearing bigger, how it comes to pass, that her Diameter being taken, it is no greater then when she appears less. But the Disquisition concerning this latter being likely to

Comprehend the former, I shall not divide my discourse into two Branches, but proceed in the Method Proposed. Only I desire it may be noted, that I suppose the *Horizontal* and *Meridional* Moon to be found both of the same Angle, whereas in truth the Meridionall Moon (tho appearing less) shall be found of the greater Angle: which increaseth the Wonder. But this proceeding from the different distances that one and t'other is looked at (the Meridional Moon being nigher us by almost a Semidiameter of the Earth) and consequently easily solved that way; I have therefore chosen to put between them a plain equality, for avoiding Confusion and Intricacy in Discourse.

Wherefore let us hear what the Ingenious of these latter days can say to this appearance. And first we find the Celebrated *Des-Cartes* attributing this appearance rather to a deceived Iudgment than to any Natural Affection of the Organ or Medium of sence; for the Moon (says he) being nigh the *Horizon*, we have a better opportunity and advantage of making an Estimate of her, by comparing her with the various objects that incur the sight, in its way towards her; so that tho we Imagine she looks bigger yet tis a meer Deceit: for we only think so, because she seems nigher the tops of Trees or Chimnys or Houses or a space of Ground, to which we can compare her, and Estimat her thereby; but when we bring her to the Test of an Instrument that cannot be deluded or Imposed upon by these appearances, then we find our Estimate wrong, and our Sences deceived. These thoughts, my-thinks, are much below the Accustomed Accuracy of the Noble *Des-Cartes*; for certainly if it be so, I may at any time increase the apparent Bigness of the Moon, tho in the Meridian; for it would be only by getting behind a Cluster of Chimnys, a Ridg of a Hill, or the top of Houses, and comparing her to them in that posture, as well as in the *Horizon*: besides if the Moon be look'd at just as shee is Rising from an *Horizon* determined by a smooth Sea, and which has no more

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Variety of Objects to compare her to, then the Pure Air; yet she will seem bigg, as if lookt at over the Rugged top of an uneven town or Rocky Country. Moreover, all Variety of adjoyning objects may be taken off, by looking through an empty Tube, and yet the deluded imagination is not at all helped thereby. I come next to the solution hereof given by the Famous *Thomas Hobbs*: and for this we shall stand in need of the first *Fig.* wherein says he, let the Point *G* be the Center of the Earth, and *F* the Eye on the surface of the Earth; on the same Center *G*, let there be struck the two Arches, *E H* determining the Atmosphere, and *AD* to Represent that blew surface in which we Imagine the fixed Stars: and let *FD* be the *Horizon*. Divide the Arch *AD* into three equal parts by the lines *BF, CF*; it is manifest that the Angle *AFB* is greater then the Angle *BFC*, and this again greater than the Angle *CFD*. Wherefore says he, to make the Angle *CFD* equal to the Angle *CFB*, the Arch *CD* must be greater then the Arch *CB*; and consequently, that the Moon may in the *Horizon* appear under the same Angle as when Elevated, she must cover a greater Arch, and therefore seem greater; that is the Moon in the Meridian appearing under the Angle *BFC*, that shee may appear under an equal Angle in the *Horizon*, as suppose *CFD*, tis necessary that Arch *CD* should be greater then *CB*; and consequently tho shee appear to subtend a greater Arch when in the *Horizon* then when Elevated, yet shee appears under the same Angle. And all this without Refraction. The Geometry of this Figure is most certainly true and Demonstrable. At this I quarrel not; but it makes no more in our present Difficulty then if nothing had been said: for the Philosopher has here made a Figure of his own, and from thence he Argues as confidently, as if Nature would accommodate herself to his Scheme, and he not Obligated to Accommodate his Scheme to Nature; for here he has made the Circle *GF* representing the Earth very large

in proportion to the Circle AD ; and then indeed taking the Point F in the Earths surface, and by lines from thence dividing the Angle AFD into what ever equal parts, the Intercepted Arches AB , BC , CD shall be unequal. But if he had considered, that the Earth is as it were a point in Respect of the Sphere of the fix'd Stars, nay the very Annual Orbit of the Earth is almost if not altogether imperceptible (saving the truth of Mr. *Hook's* Attempt) he would have found that the Lines FB , FC , FD , must be all conceived as drawn from the point G , and then equal Angles will intercept equal Arches, and equal Arches equal Angles: and so it happens (at least beyond the Possibility of discovery of sense) to the Eye on the surface of the Earth. And besides he should have considered, that all Observations Astronomical are performed as from the Center of the Earth, and therefore it is that they keep such a stir about Parallax; so that his drawing his lines so far from G as F is, and to another concentrick Circle so nigh as AD , deceived him in this Point.

The Famous *Gassendus* has written 4 large Epistles on this Subject, the substance of all which is, that the Moon being nigh the *Horizon* and looked at through a more Foggy Air, casts a weaker Light, and consequently forces not the Eye so much as when brighter; and therefore the Pupil does more enlarge it self, thereby transmitting a larger Projection on the *Retina*. In this Opinion I doe find he is not alone, for in the Journalls *des Sçavans*, this disquisition being again revived by a French *Abbe*, He therein follows this Sentiment of *Gassendus*; it was first Published in the 2^d Conferance presented to the *Dauphin* in August 1672, but by Reason of an Objection moved by Father *Pardye*, it was fain to be republished with some additions and amendments in Octob. 1672. The addition was, that this Contracting and enlarging of the Pupill causeth a different shape in the Eye; an open Pupil making the *Crystalline* flatter and the Eye longer, and the narrower Pupil shortening

ning the Eye, and making the *Crystalline* more convex, the first attends our looking at Objects which are Remote or which we think so; the latter accompanies the viewing Objects nigh at hand. Likewise an open Pupil and flat *Crystalline* attends Objects of a more Sedate Light, whilst Objects of more forcible Rays require a greater Convexity, and narrow Pupil. From these Positions the *Abbe* endeavoured to give an account of our *Phenomenon*, as follows. When the Moon is nigh the *Horizon*, by comparison with interposed Objects, we are apt to Imagine her much farther from us then when more Elevated, and therefore (says he) we order our Eyes as for viewing an Object farther from us, that is, we something enlarge the Pupil, and thereby make the *Crystalline* more flat: moreover the Duskiness of the Moon in that posture does not so much strain the sight; and consequently the Pupil will be more large, and the *Crystalline* more flat: hence a larger Image shall be projected on the Fund of the Eye, and therefore the Moon shall appear larger. And this disposition of the Eye that Magnifies her, Magnifies also the divisions of our forementioned Lattice, and consequently shee by her Body shall possess no more of the divisions, then when shee seems less. These two forementioned accidents, *viz.* the Moons Imaginary distance and Duskiness, gradually vanishing as shee rises, a different *Species* is hereby introduced in the Eye, and consequently shee seems gradually less and less, till again shee approaches nigh the *Horizon*. These two Opinions of *Gassendus* and the *Abbe* being so nigh a kin, I shall consider them both together, and first I assert that a wider or narrower Aperture increases not, neither diminishes the projection on the Retina. I know *Honoratus Faber* in his *Synopsis Optica* endeavours to prove the clear contrary to this my Assertion, and that after this manner. *Fig. II* *AB* is an Object, *EF* the greater aperture of the Pupil, admitting the projection *KI* on the Retina, whereas the lesser aperture

Aperture CD admits only the projection GH ; but GH is less than KI , wherefore a lesser Aperture diminishes the projection. I admire that any Man that undertooke (as *Honoratus Faber*) to write of Opticks more accurately than all that went before him, should be guilty of so very gross an Error; and I do more admire that the Celebrated *Gassendus*, and with him the Noble *Hevelius* should be of the same Opinion: for tho the foresaid Figure and Demonstration hold most certainly true in direct projections, as in a dark Room with a plain Hole; yet it will not hold in Projections made by Refraction, as it is in those on the *Retina* in the Eye, by means of the *Crystalline* and other Coats and Humours of the Eye. For a Demonstration of this observe the *third Fig.* wherein lett AB be a Remote Object, and EF the *Crystalline* at its large aperture, projecting the Image IM on the *Retina*. Let then CD be the lesser Aperture of the *Pupil* before the *Crystalline*: I say the Image IM shall be projected as large as before, for the Cone of Rays EAF consists partly of the Cone of Rays CAD , therefore where the former EAF is Projected, the latter CAD , as being a part of the former, shall be projected also. So that no more is effected by this narrow Aperture, but that the sides of the Radiating Cones are intercepted, and consequently the Point I shall be affected with less light, but it shall still be in the same place: what is said of that Cone and that Point may be said of all other Cones and other Points of the Object. From hence appears first, the Invalidity of the Account given of the Moons appearance by *Gassendus* from this Reason; 2^{ly}. The Reason appears why a Telescopes greater or lesser Aperture, makes no difference in the Angle it receives: for imagine EF to be an Object-Glass of a Telescope, and t'is plain. 3^{ly}. 'Tis Evident why a greater or less Aperture on a Telescope should make the Objects appear Lighter or Darker, for thereby more or less Rays are admitted to determine on the Projection of each Point. But all this
by

by the by. And this is sufficient for a Confutation of *Gassendus* and *Faber*; But our forementioned *Abbe* super-adds to a greater or lesser Aperture of the *Pupill*, as a necessary Consequent, a greater and lesser Convexity of the *Crystalline*, as also a lengthening and shortening the *Tube* of the Eye. And this I must confess would do something if we find it true in our Case; and this let us try. First says he the Duskiness of the Moon nigh the *Horizon* admits the *Pupill* to enlarge it self, the *Crystalline* to flatten, and the Eye to lengthen: but what if we change our Object, and instead of the Moon take the Distance between some of the fixt Stars; (as suppose those of *Orions* Girdle,) we shall find the same *Phænomenon* in them, and yet I hope neither he nor *Gassendus* will Assert, that they at one time strain the Eye more than at an other, or that at any time their *fulgur* strains the Eye at all; if he do, let him take Stars of the lesser Magnitudes, nay even those that can but just be perceived, and then he will be convinced: Or let him consider whether this will hold in looking at the Sun through very dark Glasses, which render the Sight thereof as inoffensive to the Eye, as that of a green Field; but perhaps he will then say that this other Reason holds which is 2^{ly}. that the greater Imaginary distance at which we think the Moon near the *Horizon*, than when more elevated, makes us Contemplate her as if really she was so, viz. with ample *Pupills*, &c. but this I have sufficiently overthrown in my Remarks against *Des-Cartes*: therefore I pass it over, only subjoyning that if there were any thing in this Surmise, my-thinks the *Horizontal* Moon should be fancied nigher to us than farther from us; for if we are for trying Natural thoughts, let us take Children to determine the Matter, who are apt to think, that could they go to the edg of that space that bounds their Sight, they should be able (as they call it) to touch the Sky; and consequently the Moon seems then rather nigher to us than farther from us.

After

After I had writ thus far I accidentally cast my Eye upon *Riccioli's* Treatise of Refraction, at the end of his 2d. Volume of the *Almagest*, Lib. 10. Sect. 6. cap. 1. Quest. 13. wherein he speaks of our present Difficulty; But to my wonder I find him Assert, that he and Father *Grimaldi* had often taken the *Horizontall* Sun and Moons Diameters by a Sextant, when to the naked Eye they appeared very large; (*Grimaldus* directing his Sight to the left edg, and *Ricciolus* to the right,) and that even by the Instrument they always found the Diameters greater than when more elevated, the Sun often subtending an Angle of almost a Degree, and frequently 45 Minutes, the Moon also 38 or 40 Minutes. This is down right contrary to the matter of Fact, which I have before alledged, and directly repugnant to the matter of Fact asserted by the *French Abbe* in the forecited Journal. Whether of us be in the right I leave to Accurate Experiment to determine, and submit the whole to the Decision of the *Illustrious Royal Society*. Only give me leave to add one word against *Riccioli*, for had his Experiments been Accurately prosecuted, he should have tryed them when the *Horizontal* Moon had look'd ten times more large in Diameter than ordinary; and then if it be true, that even by an Instrument she will be found proportionally broader than really, she should subtend an Angle of 300 Minutes, or 5 Degrees: for very often I have seen the Moon when she appeared 10 times broader than ordinary, which the small addition of 8 or 10 Minutes to her usual Diameter will never Cause.

Lastly as an Apology for my reviving this disquisition to that Noble Company of *English* Philosophers, I shall only intimate the words of the forementioned *Abbe's* Letter. *Pour la Raison de cette Apparence, & de la tromperie de nos Sens, je la tiens plus Difficile a trouver, que les plus grands Equations d'Algebre, & quand vous y aurez bien pense, vous m' Obligerez de m'en dire vostre Sentement, &c.*

After

After which I have only to Subscribe my self an unworthy Member, and an humble Servant and Admirer of that Illustrious Company.

Dublin

March 10th. 8⁶/₇

William Molynæux.

The Sentiments of the Reverend and Learned Dr. John Wallis R. S. Soc. upon the aforesaid Appearance, communicated in a Letter to the Publisher.

AS to the last Inquiry (concerning which, you say, the Royal Society would be glad to know my Opinion ;) about the apparent Magnitude of the Sun near the *Horizon*, greater than when considerably high :

The Inquiry is Ancient: And, I remember, I discoursed it near forty Years ago with Mr. *Foster*, then Professor of Astronomy in *Gresham College*. Who did then assure me (from his own Observation, I suppose ; for I have never examined it my self,) that the apparent Magnitude taken by Instrument (however the Fancy may apprehend it) is not greater at the *Horizon*, than when higher. And Mr. *Caswell* (when your Letter was communicated to our company here) affirmed the same.

And (though I have not my self made the Observation) I do not doubt but the thing is so. For it is agreed ; That Refraction near the *Horizon*, though (as to appearance) it alter the *Altitude* of the thing seen ; yet it alters not the *Azimuth* at all.

And it must needs be so. For, since this equally respects all points of the *Horizon* ; let the Refraction be
S f what

what it will, the whole *Horizon* can be but a Circle: So that there is no room for the breadth of a thing (as to the Angle at the Eye) to be made greater, what ever its Tallness may (the Refraction not equally affecting all parts in the Circles of *Altitude*.) Nor is there any reason why this should rather thrust the other, than that the other thrust this, out of place.

Whereas, in the *Altitude*, it is otherwise: For while what is near the *Horizon* is enlarged, that which is further off is thereby contracted: which as to the *Azimuth* or *Horizontal* Position cannot be.

In Spectacles indeed it is otherwise; for they represent the Object every way enlarged; and do thereby hide the adjacent parts. But in Refraction by Vapours, supposing all parts of the *Horizon* equally affected by them, one part cannot be expanded in breadth (whatever it may be as to the highth) without thrusting out an other (for the whole *Horizon* can be but a Circle) and, why one part rather than another?

Unless we would say (as perhaps we may, if there shall appear a necessity for it) That the Rays of a lucid Body do expand themselves every way to the prejudice of the parts adjacent, by covering them.

But supposing (which I am apt to believe, till the contrary shall be evinced by Experiment) that the Sun or Moon's apparent Diameter taken by Instrument near the *Horizon*, is the same as taken in a higher Position, (I mean, its *Horizontal* Diameter, or that parallel to the *Horizon*; for the erect Diameter, in a Circle Perpendicular to the *Horizon*, may by the Refraction be varied, and thereby made, not greater, but less than when higher; as hath been noted in the Name of *Sol Ellipticus* at the *Horizon*.) supposing, I say, that the Sun's apparent Diameter *Horizontal*, taken by Instrument, is the same near the *Horizon*, as in a higher Position, I take its Imaginary greatness which is fancied near the *Horizon*, to be only a deception.

tion of the Eye; or rather the Imagination from the Eye.

For sure it is, that the Imagination doth not estimate the greatness of the Object seen, only by the Angle which it makes at the Eye; but, by this compared with the supposed distance.

True it is that, *Ceteris paribus*, we judg that to be the greater Object, which makes at the Eye the greater Angle: But not so if apprehended at different Distances.

For if through a Casement (or lesser aperture) we see a House at 100 Yards distance; this House (though seen under a less Angle) doth not to us seem less than the Casement through which we see it, (or this greater than that, because it makes at the Eye the greater Angle:) But the Imagination makes a comparative Estimate from the Angle and Distance joynly considered.

So that, of two things seen under the same or equal Angles, if to one of them there be ought which gives the apprehension of a greater Distance, that to the Imagination will appear greater.

Now sure it is, that one great advantage for Estimating of a thing seen, is, from the variety of intermediate Objects between the Eye and the thing seen. For then the Imagination must allow room for all these things.

Hence it is that if we see a thing over two Hills, between which there lies a great Vally unseen, it will appear much nearer than if we see the Vally also: and it will appear as just beyond the first Hill. And if we move forward to the top of the nearest Hill (that so the Vally may be seen) it will then appear much further than before it did.

And on this account it is, that the Sun setting, appears to us as if it were but just beyond the utmost of our visible *Horizon*; because all between that and the Sun is not seen. And, upon the same account, the Heaven it self seems Contiguous to the visible *Horizon*.

Now when the Sun or Moon is near the *Horizon*, there

is a prospect of Hills, and Vallies, and Plaines, and Woods, and Rivers, and variety of Fields, and Inclosures, between it and us: which present to our Imagination a great Distance capable of receiving all these. Or, if it so chance that (in some Position) these Intermediates are not actually seen: Yet having been accustomed to see them, the Memory suggests to us a view as large as is the Visible *Horizon*.

But when the Sun or Moon is in a higher Position; we see nothing between us and them (unless perhaps some Clouds) and therefore nothing to present to our Imagination so great a Distance as the other is.

And therefore, though both be seen under the same Angle, they do not appear (to the Imagination) of the same bigness, because not both fancied at the same Distances: But that near the *Horizon* is judged bigger (because supposed farther off) than the same when at a greater *Altitude*.

'Tis true, that as to small and middling Distances (beside this Estimate from Intermediates) the Eye hath a means within it self to make some Estimate of the Distance. As, when we already know the bigness of a thing seen, to which we have been accustomed; as a Man, a Tree, a House, or the like: If such thing appear to us under a small Angle, and indistinct, and faintly coloured; the Imagination doth allow such Distance, as to make such a thing so to appear. And, if this, through a Prospective Glass, be represented to us under a bigger Angle, and more distinct: It is accordingly apprehended as so much nearer.

But the case is otherwise, when we do not, by the known bigness, judge the Distance; but, by the supposed Distance, judge of the bigness; as in the Case before us.

And accordingly, different Persons, according to different fancied Distances, judge very differently. As, if two Stars be shewed to Ignorant Persons, and you ask how far they

they seem to be afunder: one perhaps will fay, a Foot; another, a Yard, or more: And one fhall fay, The Sun appears to him as big as a Buſhel; another, as big as a *Holland Cheefe*: Each eſtimating according to the fancied Diſtance.

Again; in our two *Eyes* (when the Object is ſeen by both) there is yet another means of Eſtimating how far off it is. (And it is this by which we judge of Diſtances.) Namely, there are, from the ſame Object, two different viſual Cones, terminated at the two *Eyes*: Whoſe two Axes contain, at the Object, different Angles, according to different Diſtances: An acuter Angle at a great Diſtance, and more obtuſe when nearer.

Now, that ſuch Object may be ſeen by both *Eyes*, clearly; it is requiſite that the *Eyes* be put into ſuch a Poſition, as that the Sight of each *Eye* receive the reſpective Axe at right Angles. Which requires a different Poſition of the two *Eyes*, according to the different Diſtance of the Object.

As will manifeſtly appear; if we look, with attention, on a Finger (or other ſmall Object) at two or three Inches diſtance from the *Eye*; and then upon another like Object at three or four Yards beyond it: (and this alternately ſeveral times.) For 'twill be manifeſt, that while we look intently on the one, we do not ſee the other (or but confuſedly) though both be juſt before us. And, as we change our view, from the one to the other, we manifeſtly feel a Motion of the *Eyes* (by their Muſcles) from one poſture to another.

And according to the different Poſture in the *Eyes*, requiſite to a clear Viſion by both, we eſtimate the Diſtance of the Object from us.

And hence it is, that they who have loſt the Sight of one *Eye*, are at a great diſadvantage, as to eſtimating Diſtances, from what they could do while they had the uſe of both.

But

But now when the Distance grows so great, as that the Position of these visual Axes become Parallel, or so near to Parallel, as not to be distinguishable from it: This advantage is lost, and we can thenceforth only conclude, that it is far off; but not how far.

Hence it is, that our view can make no distinction of the Moons Distance, from that of the other Planets, or even of the fixed Stars: But they seem to us as equally remote from us; though we otherwise know their Distances from us to be vastly different. Because the Parallax (as I may so call it) from the different Position of the two Eyes, is quite lost, and undiscernable, in Distances much less than the least of these.

And so, of the fixed Stars amongst themselves: Which, though they seem equally remote from us; many (for ought we know) be at Distances vastly different. Nor can we tell, which of them is nearest: (unless perhaps we may reasonably guess, those to be nearest, which seem biggest.) Because, here not only the Parallax from the Distance of the two Eyes; and that from the Earths Semidiameter; but even that from the Semidiameter of the Earths great Orb, is quite lost; and none remaining, whereby to estimate their Distance from us.

But (to return to our case in hand;) though as to small Distances, we may make some estimate from the known *Magnitude* of the Object: And, as to middling distances, from the Parallax (as I may call it) arising from the interval of the two Eyes: Yet even this latter will hardly reach beyond, if so far as the visible *Horizon*: and all beyond it, is lost.

So that, there being nothing left to assist the fancy in estimating so great a distance, but only the intermediate Objects: Where these intermediates appear to the Eye, (as, when the Sun or Moon are near the *Horizon*:) the distance is fancied greater, than where they appear not, (as when farther from it:) and consequently (though both

both under the same or equal Angles) that near the *Horizon* is fancied the greater. And this I judg to be the true reason of that appearance.

You will excuse (I hope) what excursion I have made; because though some of them might have beed spared, as to the present case; yet they are not impertinent to the Business of Vision; and the estimate to be thence made, of *Magnitudes* and Distances, by the Imagination.

The Suns Eclipse *May 1st*. was here observed about $\frac{1}{2}$ a Digit; between one and two a Clock after noon.

Account of a B O O K.

A Continuation of the New Digester of Bones: It's Improvements and new Uses it hath been applied to, both at Sea and Land.

Together with some Improvements and new Uses of the Ayre Pump, tryed both in England and Italy.
By D. Papin M. D. Fellow of the Royal Society.

THIS Treatise is divided into three Sections; the first contains the Improvements made by the Author on the Digester; with the new Uses it hath been apply'd to. First is given the Description of that which he had made for His Majesty King *Charles the 2^d*. of blessed Memory; and he doth not think (considering the alterations whereby this exceeds the first Invention) that any thing better can be made for such things, as must be stew'd in their own Juices: But for other things that must be boil'd with Water, as Pulse, Gellies, &c. He gives the Description of another Engine, which he finds to be, for seven
Rea-

Reasons, preferable to the other ; so as that a small Engine of this Fashion, if it holds but 6 or 7 Pounds of Water, will be enough to make 150 Pounds of Gelly in 24 Hours, and will not consume above 11 Pounds of Charcoal. He doth afterwards relate the new Uses this Engine hath been applyed to, but for brevities sake, I will mention but one that seems to be very considerable. He hath tryed, that Bones being as much salted as Bones can be, if they be left to soak in Sea Water, as they do for the Meat at Sea, they will be fit to make fresh Gelly several times: so that all the Bones that are thrown away as useless in long Voyages, may henceforth serve to make a Food wholsomer and better, than the Meat it self. The Author doth afterwards relate, how these Gellies may be applyed for the preserving of Summer Fruits: Upon this he alledgeth many Experiments, which give him Occasion to make several Observations ; as for Example, he saith that *Strawberries* that are brought up by Art in the latter Season, have much less Spirits, than those that ripen in the Spring of the Year : So that some *Strawberries* which he had thus shut up in the Month of *October*, became very sower in 3 Months time ; whereas other *Strawberries* which he shut up in the Month of *June*, having been kept 8 Months, were not sower at all, but had given a Vinous Taste to the Gelly : He doth afterwards impart his Way for making and clarifying Gellies, which hath given him Occasion to contrive two Engines for filtrating quickly, and a contrivance how to make *Evaporations* quicker, and with less Fire than they use to be done, and these are very plainly described in the Book. He gives also the description of an Engine for distilling *per descensum* in several degrees of Rarefaction and Condensation of Air ; and he gives an Account of some Experiments which he hath already made with this Instrument, from whence it appears, that in some Cases the Condensation of the Air will be of great advantage for a quick Distillation.

In the second Section are explain'd the Improvements made by the Author, on the *Pneumatick* Engine; and he doth not think, that ever any hath been so good as his: he gives a full Description of it, and takes Notice of all that contributes to its exactness; and he relates some Experiments that he hath made to prove his Assertion: He doth by the by, Answer Mr. *Bernoulli*, who hath written something against the Honourable Mr. *Boile*, about the weighing of the Air in a Bladder; and afterwards he comes to the new Uses this Engine hath lately been apply'd to; whereof I will mention but this, that seems to be of great Moment, because without any Sugar or any other alteration, than what can be made by a little boiling; he can preserve great Quantities of Fruit with their Taste: The Way is this; he shuts up the Fruits in Glass Vessels exhausted of the Air, and then puts the Vessel thus exhausted in hot Water, and lets it stand there for some while; and that is enough to keep the Fruit from the Fermentation, which otherwise would undoubtedly happen: Yet it is observable, that this is not generally true: but that it is good to have several ways for the preserving of Fruit: *Rasberries*, for Example, that keep in Gelly better than any other Fruit, cannot be preserved although they be heated *in vacuo*. Such or the like Observations are annexed to almost every Experiment, at the latter end of this Section, the Author answers such Objections as may be brought against the real usefulness of these Engines; whereupon he describes a Way how to exhaust the Air very speedily out of great Vessels, to be kept thus exhausted as long as we please.

The third Section gives a Relation of what hath been done in two Years time, in Mr. *Sarrotti's* Academy at *Venice*; which had some Relation to the Matter treated of in this Book: There may be seen several new and curious Experiments about Matters of Moment: But I shall only relate two of them, from whence the reader may judge

T t

of

of the rest; the first is, that two equal pieces of *Iron* were put at the same time into two equal Quantities of *Aqua-fortis*, the one *in vacuo*, and the other in the open Air; and being afterwards taken out at the same time; it was found that the *Iron* in the open Air, had been 16 times more dissolved than the *Iron in vacuo*.

The second Experiment is, that two equal Quantities of *Roses* were put into two Instruments for Distillations, like one another; but the one was exhausted of Air, and the other was full; the Distillation was abundantly greater and quicker in the evacuated Instrument, than in the other, although they were both heated by the same warm Water; it was also observable, that the *Rose Water* distilled *in vacuo* did congeal, which doth not happen in ordinary Distillations: So it is plain, that in some Circumstances, the *Vacuum* helps Distillations; as well as in the first Section it was seen, that in other Circumstances the compression of Air is more advantagious. In this whole Section are intermixed the reasonings of the Academy, about the Matters in hand, and two Discourses made in the Academy, by *Sigr. Ambrosio Sarrotti* in the beginning of each Year: So the Reader may here be diverted as well as instructed in the Operations of Nature. It may be said in short, that it is rare to see a Book, that in so small a Volume doth contain so many things recommendable, both for Usefulness and Novelty; but no Wonder, since it is owing to the Instructions and Directions of the R. S. as the Author acknowledgeth in his *Epistle*, which he inscribeth to my Lord of *Carbery*, President of that Illustrious Company. Nevertheless, the better to convince those that would question either the Truth, or the Usefulness of the Contents of his Book; the Author engageth to let People see them try'd once a Week, and he appoints a certain Time and Place for that Purpose.

London, Printed by *J. Streater*, and sold by *S. Smith*, at the *Prince's Arms*, in *St. Paul's Church-Yard*.

PHILOSOPHICAL TRANSACTIONS

For the Months of *July* and *August* 1687.

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Ob-

Observations of what did præternaturally occur in the opening of the Body of Mr. Smith of Highgate July 8th. 1687. Communicated by that learned Physitian Dr. Edward Tyson Reg. Soc. Soc.

IN the first place dividing the *Abdomen*, immediately upon *Incision* made into the *Peritonæum*, we discovered the Bladder very *Schirrous* and thick, viz. $\frac{1}{4}$ of an Inch ; of a Præternatural Figure, and distended to the bigness of a Childs Head: And at the entrance of the *Ureters* on each side were two *Protuberancies*, of the bigness of a Hens Egg each; the *Ureters* were of the largeness of the small Gutts in Children, so that they could easily admit two fingers into their Cavity. They were both repleat with Urine or a serous matter ; which upon pressure did easily regurgitate into the Kidneys, but would not pass at all into the Bladder. The Kidneys were of their Natural bigness and Figure, but so emaciated that they were rather large Bags than of a fleshy Substance ; The Cavity of the *Pelvis* being so large as to contain above 3 ounces of Water : But to return to the Bladder; therein upon *Apertion* we discovered a very strange sort of *Cystes* or Bags, of the exact Figure of Eggs, of several dimensions, some larger than Goose Eggs, others as big as Hen Eggs, to the number of twelve in all ; and about eight of them whole and repleat with a Limpid *Serum* : The Coats of these Bladders were some of them considerably thick, others very thin and tender ; all of them loose and free without the least adhesion, either to one another or to the Coat of the Bladder. There was little or no Urine in the Bladder but
what

what was contained in these Bags. Nor could we Imagine that this miserable Patient could possibly make any Water, but what happened upon the breach of some of these Watery Tumours, when the Bladder was crouded beyond its dimensions; for that the passage by the *Ureters* into the Bladder was impervious: And though the *Ureters* were full of *Serum*, yet could none be forced into the Cavity of the Bladder.

This Liquor contained in these Baggs, we did conjecture to be of the Nutritious juice of the Body; and upon tryal of boyling a small quantity of it, we found it thicken and come to the consistence of a stiff and glutinous Gelly. These *Vesiculæ* were undoubtedly formed from the tenacity of the matter between the Membranes of the Bladder, in its oblique passage through them; for that being so glutinous, it was here detained till its Superficies were condensed into a firm Coat, and so by the coming of more matter was forced into the Cavity of the Bladder. This I suppose, from our finding two of these *Ova* in a distinct *Sinus* from the rest, between the Coats of the Bladder, at the entrance of each *Ureter*.

The Liver we found very large and hard, of the Colour and Substance of a boyled one. It adhered to the *Peritoneum* on the external part, and by its vast bigness had so straitned the *Thorax*, that there was very little room for the Lungs.

The Lungs we found of a livid Colour, adhering close to the *Pleura* on the right side; upon Incision we found them wholly repleat with a Purulent matter, and a Stone of the bigness of a Cherry-Stone in one Lobe.

Dividing the *Pericardium* we found a Fungous Substance covering the Heart all over; and *Fibres* from it, that rann to the *Pericardium* in a great number; so that they were by these *Fibres* every where united.

The Heart was very large, the right *Auricle* and *Ventricle* were one large undivided Cavity, and therein a large
Polypus;

Polypus; which run up the descending Branch of the *Vena Cava* to the very *Jugular*, another Part was distributed to the *Pulmonary Artery*.

In the left *Ventricle* was another *Polypus* not so large as the former: it had two Branches, one in the *Pulmonary Vein*, another in the *Arteria Magna*, or *Aorta*.

One of the *Vesiculæ* being opened had a large cluster of small *Ova* as big as Grapes, all repleat with *Liquor*: All the rest contained nothing but *Serum*.

A Relation of an extraordinary effect of the power of Imagination: Communicated by Mr. Edward Smith, Secretary to the Philosophical Society at Dublin, as it was brought before that Company, by Mr. St. George Ash. R. Soc. S. who had seen the thing.

One Elizabeth Dooly of the County of Kilkenny was aged 13 Years in January last: Her Mother being with Child of her was frighted by a Cow as she milked it, thrown down and hit on her Temple, within an eighth of an Inch of her Eye, by the Cows Teat. This Child has exactly in that place, a peice of Flesh resembling a Cows Teat, about 3 Inches and half in length: 'Tis very red, has a Bone in the midst about half the length of it; tis perforated and she Weeps through it; when she Laughs it wrinkles up and contracts to two thirds of its length, and it grows in proportion to the rest of her Body. She is as sensible there as in any other part. This is lookt upon to be as strange an instance of the strength of Imagination as can be produced.

De Constructione Problematum Solidorum, five
Æquationum tertiæ vel quartæ Potestatis, unica
data Parabola ac Circulo efficienda; dissertati-
uncula: Authore *Edm. Halley*.

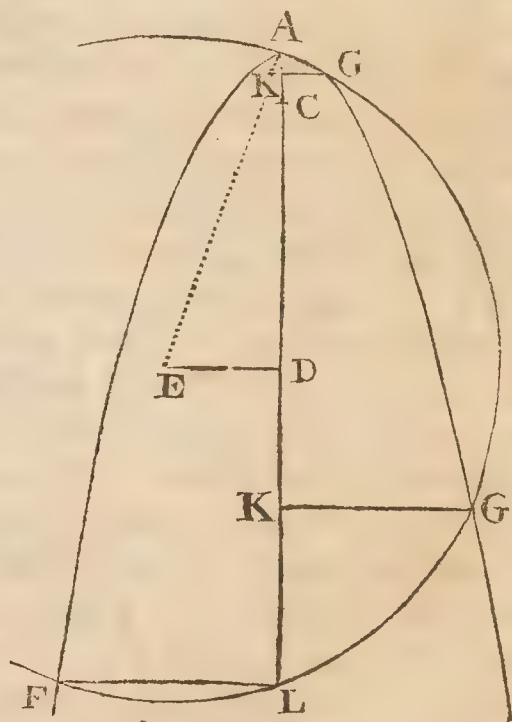
QUo pacto æquationes omnes Cubum vel Quadrato-quadratum quantitatis incognitæ involventes, ope Parabolæ cujuscunq; datæ & Circuli, construi possint, clare tradit ac Liquidò demonstrat præclarus ille Cartesius in *Lib. III. Geometriæ suæ*: sed primum jubet secundum æquationis terminum, si adfuerit, tollere, ac deinde reduktæ æquationis Radices regula ibidem exposita elicere. Cum vero operatio ista nimis laboriosa videatur, nonnullis visum est constructionem similem etiam absq; ulla prævia reductione comminisci; inter quos Franciscus a Schooten Methodum valde facilem ac simplicissimam pro construendis Cubicis quomodolibet affectis prodidisset, si modo exposito principio unde regulam derivavit, Lectoris memoriæ, quam plurimis ac intricatis cautionibus obruit, melius studuisset. Nuper vero Vir Cl. D. Thomas Baker nostras, integro libello de constructionibus hisce conscripto, non solum Cubicas sed etiam Biquadraticas omnes cujuscunq; generis unica generali regula complexus est, eamq; demonstrationibus ac Exemplis per omnes casus abunde satis illustravit; nec non sub finem modum proponit unde regula ista generalis investigari possit: Haud tamen illum ipsum ostendit, cujus ope (uti suspicor) Clavem suam Geometricam Catholicam obtinuit, vel saltem multo facilius obtinere potuit. Cumq; perplexis cautionibus de signis $+$ & $-$ Regula hæc D. Bakeri non minus obnoxia sit quam illa Schooteni, ut vix absente libro constructiones illas quis tuto peragat; haud injucundum nec Tyronibus incommodum fore vi-

sum est, utriusq; fundamentum exponere, ac simul emendata methode, in re tam difficili, lucem quantum valeam afferre.

Constructio quam tradit Cartesius, quæq; facillime radices æquationum omnium Cubicarum vel biquadraticarum, ubi deficit secundus terminus, eruit, ut nota supponi potest; attamen cum cardo sit a quo subsequencia pendent, ne dissertatiuncula hæc capite truncata videatur, ex illius Geometria desumptam placuit Regulam adjungere, pauculis nonnullis in melius uti reor transpositis.

Deficiente secundo termino omnes æquationes Cubicæ reducuntur ad hanc formam $z^3 .*. a p z. a a q. = 0$, ac Biquadraticæ ad hanc $z^4 .*. a p z z. a a q z. a^3 r = 0$. (ubi a designat Latus rectum Parabolæ cujuscvis datæ, quam in Constructione adhibere licet.) vel sumendo a pro Unitate, ad hanc $z^3 .*. p z. q = 0$, vel ad hanc $z^4 .*. p z z, q z. r = 0$.

Jam data Parabola F-A-G cujus Axis sit A-C-D-K-L ac latus rectum a vel 1, fiat A-C ejus dimidium ac collocetur semper a vertice A versus interiora figuræ: dein sumatur $C D = \frac{1}{2} p$ in linea illa A-C continuata versus C si in æquatione fuerit $-p$, vel versus alteram partem si habeatur $+p$. Porro e puncto D, aut ex puncto C si non habeatur quantitas p , erigenda est ad axem perpendicularis D-E æqualis $\frac{1}{2} q$, dextror-



sum quidem si fuerit $-q$, ad alterum vero axis latus si fuerit $+q$; ac Circulus centro E radio A-E descriptus, si æquatio fuerit tantum Cubica, Parabola tot punctis F & G intersecabit quot veras habet Radices, quarum quidem affirmativæ ut G-K erunt

erunt ad dextram Axis partem, Negativæ ut F L ad sinistram.

Ast si Æquatio Biquadratica fuerit, augeri vel minui debet Circuli Radius A E, addendo si fuerit $-r$, vel subducendo, si sit $+r$, ex ejus quadrato rectangulum ar , seu contentum sub Late-
re recto & quantitate data r ; id quod nullo fere negotio efficitur Geometrice. Hujus vero Circuli intersectiones cum Parabola omnes veras Biquadraticæ Æquationis radices dimissis ad Ax-
em perpendiculis exhibebunt; Affirmativas quidem ad dextram Axis, Negativas vero ad sinistram. Totius demonstrationem Cartesio ejus inventori relinqno.

Notandum hic me operam dare ut semper habeantur Radices affirmativæ ad dextrum Axis latus, ut evitetur confusio a plu-
ribus cautionibus, quarum causa minime evidens est, necessario oritura.

His præmissis, ut aditus pateat ad constructionem etiam earum æquationum ubi reperitur terminus secundus, considerata venit regula pro tollendo termino secundo, ac reducenda æquatione ad aliam quæ methodo præcedente construi possit. Omnes vero hujus classis æquationes cubicæ ad hanc formam $z^3. bz z. apz. aaq = 0$, vel ad hanc $z^3. bz z. *.aaq = 0$. Biquadraticæ vero ad hanc $z^4. bz^3. apz z. aaq z. a^3 r = 0$, vel hanc $z^4. bz^3. *.aaq z. a^3 r = 0$, vel $z^4. bz^3. apz z. *.a^3 r = 0$ vel deniq; ad hanc $z^4. bz^3. *. *.a^3 r = 0$ reduci possunt; e quibus omnibus, prout signis $+$ & $-$ diversimode connectuntur, ingens oritur varietas; unde Regula generalis omnibus inservi-
ens obscura ac maxime difficilis redditur, nisi methodo quam sub-
jungimus illustrata nodisq; extricata tractetur.

Tollitur in Biquadraticis secundus terminus, ponendo $x = z + \frac{1}{4}b$, si fuerit $+b$ in æquatione, vel $x = z - \frac{1}{4}b$, si fuerit $-b$: hinc $x - \frac{1}{4}b$ in prima casu, & $+ \frac{1}{4}b$ in altero æquatur z ; & in æquatione quavis proposita, substituta loco z quantitate æquali, prodibit nova æquatio termino secundo carens, cujus ra-
dices omnes x data differentia $\frac{1}{4}b$ vel excedunt vel deficiunt a radice quæsita z : Cum vero in rebus istiusmodi plus exempla quam præcepta valere solent, proponatur una vel altera æquatio Construenda.

Exemp. I.

$$z^4 + bz^3 - apzz - aaqz + aaar = 0.$$

$$\text{Sit } x - \frac{1}{4}b = z$$

Et erit

$$xx - \frac{1}{2}bx + \frac{1}{16}bb = zz$$

$$xxx - \frac{3}{4}xxb + \frac{3}{16}xbb - \frac{1}{64}bbb = z^3$$

$$\text{Et } x^4 - bx^3 + \frac{3}{8}bbxx - \frac{1}{16}b^3x + \frac{1}{256}b^4 = z^4.$$

hinc.

$$x^4 - bx^3 + \frac{3}{8}bbxx - \frac{1}{16}b^3x + \frac{1}{256}b^4 = z^4$$

$$+ bx^3 - \frac{3}{4}bbxx + \frac{3}{16}b^3x - \frac{1}{64}b^4 = +bz^3$$

$$- apxx + \frac{1}{2}apbx - \frac{1}{16}apbb = -apzz$$

$$- aaqx + \frac{1}{4}aaqb = -aaqz$$

$$+ aaar$$

Harum omnium summa fit æquatio nova secundo termino carens, quæq; proinde juxta regulam Cartesianam construi possit, sumendo loco $\frac{1}{2}p$ dimidium coefficientis termini tertii per a sive Latus rectum divisi, hoc est $-\frac{3}{16}\frac{bb}{a} - \frac{1}{2}p$; ac Loco $\frac{1}{2}q$, dimidi-

um coefficientis termini quarti per aa divisi, sive $+\frac{1}{16}\frac{bbb}{aa}$

$+\frac{1}{4}\frac{pb}{a} - \frac{1}{2}q$. Cujus partes signo $+$ notatæ sinistrorsum ab

Axe, signo $-$ notatæ dextrorsum collocandæ sunt, ut habeatur centrum Circuli ad constructionem requisiti, ac cujus intersectiones cum Parabola, dimissis in axem perpendiculis, radices omnes veras x designet, affirmativas quidem ad dextram axis, negativas vero ad sinistram. Cum vero $x - \frac{1}{4}b = z$, ducendo lineam Axi parallelam, ad dextrum ejus latus Et ad distantiam $\frac{1}{4}b$, perpendicula illa ad hanc parallelam terminata designabunt omnes radices quæsitæ z , affirmativas ad dextram, negativas vero ad sinistram. Radium circuli quod attinet, habetur ille addendo partes negativas ac auferendo partes affirmativas termini quinti per aa divisi, e quadrato lineæ AE , a centro invento E ad

Ver-

Verticem Parabolæ A ductæ : id quod maxima ex parte efficitur capiendo loco lineæ A E lineam E O, quæ ad O intersectionem Parabolæ ac parallelæ prædictæ terminatur ; ejus enim quadratum omnes termini quinti partes ex ablatione termini secundi æquationi novæ ingestas complectitur (uti facile probabitur :) ac restat solummodo ut ipsius E O quadratum augeatur, si in æquatione habeatur $-r$, vel minuatur si sit $+r$, additione vel subtractione rectanguli ar , unde conflatur quadratum Radii Circuli quæsitum.

Hæc est methodus investigandi regulam centralem Dni Bakeri omnibus cautionibus libera ac satis facilis ; ac sola differentia ex eo provenit, quod ego juxta Axem, ille vero juxta Axi parallelam circuli ejusdem centrum determinat : quodq; ego semper radices affirmativas ex Axis dextro latere invenio, quas ille nunc dextro nunc sinistro constituit.

Æquationes cubicas quod attinet, eæ reduci debent ad Biquadraticas, antequam eadem regula generali construi possint ; id quod fit ducendo æquationem propositam in radicem suam z , unde provenit æquatio Biquadratica in qua deficit terminus ultimus sive r : quapropter sublato secundo termino & invento centro E, lineæ E O est radius Circuli ; cum scilicet ar sit $= 0$, & in nova æquatione totus terminus quintus ex ipsa ablatione termini secundi oriatur. Construenda sit hæc æquatio.

Exemp. II.

$$z^3 - bzz + apz + aaq = 0: \text{ Quæ ducta in } z \text{ fit}$$

$$z^4 - bz^3 + apzz + aaqz = 0$$

Ad tollendum secundum terminum ponatur $x + \frac{1}{4}b = z$, & fiet

$$\begin{aligned} x^4 + bx^3 + \frac{3}{8}b^2xx + \frac{1}{16}b^3x + \frac{1}{256}b^4 &= +z^4 \\ -bx^3 - \frac{3}{4}b^2xx - \frac{1}{16}b^3x - \frac{1}{64}b^4 &= -bz^3 \\ +apxx + \frac{1}{2}abpx + \frac{1}{16}apbb &= +apzz \\ +aaqx + \frac{1}{4}aaqb &= +aaqz \end{aligned}$$

In hac nova Æquatione, tertii termini semicoefficientis per a divisa, viz. $= \frac{3bb}{16a} + \frac{1}{2}p$, loco $\frac{1}{2}p$ usurpanda est ; ac coeffi-

W W

cientis

cientis termini quarti dimidium, divisum per a a Lateris recti quadratum, viz. $-\frac{b b b}{16 a a} + \frac{p b}{4 a} + \frac{1}{2} q$, vicem ipsius $\frac{1}{2} q$ in constructione Cartesii subit; unde centrum E determinatur. Deinde ducta Axi parallela ad distantiam $\frac{1}{4} b$ ad sinistrum ejus latus (ob $x + \frac{1}{4} b = z$) cujus intersectio cum Parabola sit O ; circulus centro E , Radio EO descriptus Parabolam secet vel tanget in tot punctis quot aequatio veras habet radices: quae quidem radices seu z sunt perpendiculara de punctis illis in Axi parallelam demissa; ad dextram quidem Affirmativa, Negativa ad sinistram.

Si in aequatione defuerit terminus tertius vel quartus vel uterq;, in investiganda regula centrali nulla omnino observanda est methodus differentia, sed deficiente quantitate p vel q , derunt partes illae linearum CD ac DE ex quantitate illa aliquo modo deductae, ac procedendum est cum reliquis coefficientibus termini tertii & quarti in aequatione nova, sicut in praemissis exemplis praescriptum est.

Hactenus Cl. Bakeri methodum generalem pertractavimus, qua quidem nulla alia facilior ac paratior expectanda est, assumpta ad constructionem siue Parabola, siue alia quaevis linea curva, cum scilicet aequatio ad Biquadraticam ascendit. Etenim dum hac scribo mihi occurrit regula Centralis Effectio Geometrica praeter omnem spem expedita, ac harum rerum Curiosus abunde satisfactura.

Descripta Parabola NAM , cujus vertex A , Axis ABC ac latus rectum a , reducatur aequatio ad hanc formam $z^4 + b z^3 + a p z z + a a q z + a^3 r = 0$ vel ad hanc $z^3 + b z z + a p z + a a q = 0$ si cubica tantum fuerit: dein ad distantiam $BD = \frac{1}{4} b$ ducatur linea DH Axi parallela, ad sinistram quidem si fuerit $-b$, ad dextram si $+b$, parabola occurrens in puncto D ; de quo dimittatur perpendicularum in axem BD . In linea AB continuata versus B fiat $BK = \frac{1}{2} a$, & ducatur linea DK utrinque interminata. Porro sit $KC = 2 AB$ in Axe semper ultra K continuato; ac si habeatur quantitas p signo $-$ affecta, versus easdem partes etiam sumatur $CE = \frac{1}{2} p$, vel in contrarias, si

si habeatur $+p$, ac e puncto E erigatur Axæ perpendicularum EF (vel e puncto C si defuerit quantitas p) linea DK, si opus est continuata, occurrens in puncto F; quod quidem circuli requisiti centrum est, si

defuerit quantitas q ; Ast si habeatur

q , sumenda est in FE, si opus est continuata, linea

$FG = \frac{1}{2}q$, sinist-

rorsum quidem si fuerit $+q$, dex-

trorsum si $-q$ col-

locanda: Et punc-

tum Gerit centrum

circuli ad construc-

tionem propositam

idonei; ejusq; Ra-

dius, si defuerit

quantitas r , hoc est

si tantum cubica fu-

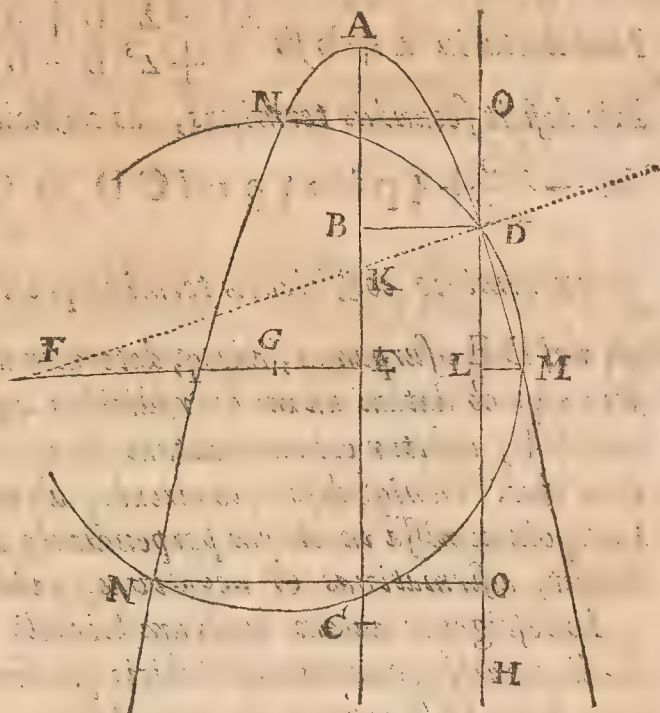
erit, erit linea GD; cujus quadratum in Biquadraticis augendum

est, si fuerit $-r$, vel minuendum si $+r$ additione vel subductione

rectanguli sub r & latere recto. Descripto sic Circulo, ab in-

tersectionibus ejus cum Parabola demissis in lineam DH perpen-

diculis, quæ ad sinistram sunt, ut NO, radices æquationis nega-



ativas semper designant, quæ ad dextram ut ML affirmativas.

Aliter ac paulo simplicius Aequationes cubicae juxta Schootenii Regulam construuntur, quæ etiam radices ad Axem referuntur: quoniam vero ipse inventor nec modum inveniendi nec demonstrationem inventi exponit, non abs re erit ejusdem fundamentum hic adjicere, simul atq; Effectiorem Geometricam concinniorem reddere, atq; cautionibus quibus implicatur extricare.

Hæc Regula derivatur ex eo quod omnis æquatio Cubica reduci possit ad Biquadraticam, in qua deficiet terminus secundus: Hoc fit ducendo æquationem propositam in $z - b = 0$, si fuerit $+b$ in

æquatione, vel in $z + b = 0$, si fuerit $-b$; & æquatio nova producta easdem habebit radices cum Cubica, atq; insuper alteram ipsi $-b$ æqualem, si fuerit $-b$ in æquatione; vel contra.

Proponatur construenda $z^3 - z^2 b + a p z + a a q = 0$.

Hæc ducta in $z + b$ fit $z^4 - z^3 b + a p z^2 + a a q z + z^3 b - b b z z + a b p z + a a q b$.

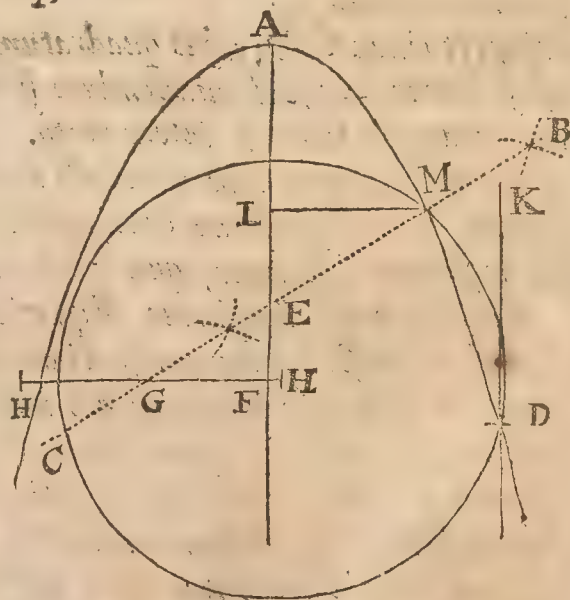
Hic deficit secundus terminus, ac coefficientis tertii $-b b + a p$ dat $-\frac{b b}{2 a} + \frac{1}{2} p$ loco $\frac{1}{2} p$ vel $C D$ in Constructione Cartesii,

& ex dimidio coefficientis termini quarti fit $+\frac{1}{2} q + \frac{b p}{2 a}$ loco

$\frac{1}{2} q$ vel $D E$ usurpanda; adeoq; determinatur centrum circuli quaesiti: atq; ob datam unam ex radicibus æquationis novæ, viz. $-$ vel $+b$, dabitur etiam punctum in circumferentia, id est Radius ejus. Deniq; descripto circulo, ab intersectionibus ejus cum Parabola demissa in Axem perpendiculara æquationis radices exhibebunt, affirmativas & negativas, eadem lege ac supra.

Investigatur autem centrum Circuli constructione perquam facili, cæterisq; omnibus in Cubicis præferenda. Descriptæ Parabola $A M D$ sit vertex A , atq; Axis

$A F$: ad distantiam ipsi b æqualem ducatur Axi parallela $D K$, ad dextram si fuerit $+b$ in æquatione, ad sinistram si $-b$, quæ Parabola occurrat in puncto D . Centris D & A describantur radiis æqualibus arcus occulti utrinq; sese intersecantes, ac per sectionum puncta ducatur linea interminata $B C$, quæ medio lineæ suppositæ $A D$ perpendiculariter insistant,



& Axi occurrat in puncto E . Ab E , inferne quidem si in æquatione habeatur $-p$, vel superne versus A si fuerit $+p$, ponatur

tur $EF = \frac{1}{2} p$; & ex F (vel ex E si defuerit p) educatur perpendicularum FG, linea BC occurrens in puncto G; & in GF producta fiat $GH = \frac{1}{2} q$, dextrorsum quidem si in equatione habeatur $-q$, aliter sinistrorsum, applicanda: ac punctum H erit centrum quæsitum, HD vero circuli Radius, qui demissis in axem perpendicularis ab intersectionibus suis cum Parabola, ut LM, Radices omnes, ut prius, commonstrabit. Quomodo vero constructio hæc ex præmissis consequatur, per se satis edens est, nec opus est ut in eadem demonstranda diutius immorer.

Ne in his edendis frustraneam navasse operam, & ex aliorum inventis gloriolam capere videar, consulat Lector Cl. Bakeri librum Anno 1684 Londini editum, & quæ de hoc Argumento scripsi a Schooten in Commentario suo in Librum III. Geometriae Cartesiana. Brevis concessio otio tractatulum alium de numero Radicum in huiusmodi Aequationibus, earumq; limitibus, ex contemplatione Constructionum præcedentium, aggredi ac in lucem proferre statuo.

A Letter of Mr. De la Hire of the Royal Academy of the Sciences at Paris, concerning a new sort of Magnetical Compass, with several curious Magnetical Experiments.

YOU know Sr. that there is nothing which creates so much trouble in long Voiages on the Sea, as the Variation of the Magneticall Needle, both because this Variation is different in differing places, and because in the same place it changes considerably in process of time. It seems that if wee had exact Observations of the irregularities of this Variation, made all over the Earth, and at a considerable interval of time, one might discover some Period of this Motion, and establish a System which might be of great use in Navigation. But seeing our oldest Observations were made but about a hundred Years since, and in some particular places only, they only serve to let us know, that if there be a regular Motion, it must needs be very slow: So that we can conclude nothing certain for the time to come from all that has been hitherto Observed. This is not because of any difficulty that there is in ascertaining this variation by Observation, since it is found to Change but few Minutes in a Year; but too much reliance must not be upon the Observations of Pilotes, by reason of the gross Errors which it is not easy for them to prevent. For it often happens that near the place where the Compass is, there is much Iron, which draws the Needle, and causes it to shew a point on the Horizon much different from what it would, were it farther from the Iron; which makes it be thought that there is a considerable Variation where perhaps there is none

at all. And it may so happen that in the same place where the Year before an Observation was made, if in the next, the Iron Instruments be found otherwise placed than they were the time before, either in the same Shipp or another, the Needle will shew a Variation much differing from that found the first time. And this sort of Caution not being Observed at Sea may be cause of very great Errours in the Observations of the Needles Variation tho' not affecting the Course of the Vessel. For the Needle being drawn after a certain manner will constantly observe the same situation in respect of the North, provided the Iron round about it be not stirrd: And you shall not faile to steer true upon any point of the Compass, if this false Variation be observed after the usual Manner by the Amplitudes of the Sun. We cannot therefore hope to be secure of any thing from the Observations we have at present, and especially from those made at Sea, which are the most considerable. This put me upon finding out some means independent from Observations to discover the Variation at Sea; but having considered that several learned Men of this age had proposed divers ways of making Magnetical Needles, which should not be subject to Variation, and that all these propositions had had no effect; I judged that after all that they had done by means of the Loadstone, it was not to be hoped to draw any farther advantage from it; since the Stone it self, as far as might be guessed from the Experiments hitherto made, was subject to the same Variation:

I had quite given over this Enquirie, when there accidentally fell into my hands a *Terrella* or Spherical Loadstone, of three Inches Diameter; with which being minded to make some Experiments, with a little Needle whose foot might easily be placed upon the Stone, I soon Observed that which hath been already noted by several, *viz.* that this Globe of Magnet caused the Needle to have the same changes which are found in the Compass in different

rent parts of the World, as well in respect of the direction towards the two Poles, as of the Inclination towards that which is next it: and upon tryal I satisfied my self that it was not possible to find the Point where the Needle would stand indifferently in any position, (which Point would have exactly shewed me the Pole of the Stone) but that the Needle however placed, always directed it self some one way. I determined by this means, as well as I could, the Point called the South Pole; but I was much surpris'd to find it 18 Degrees distant from a Cross deep engraven on the Stone, which according to all appearance had heretofore been the Pole of this Stone, as it had been Observed by him that Cut it. This change of the Poles of this Stone having revived my former thoughts concerning the Variation of the Needle, I believed that if it were true that the Poles of the Magneticall Vertue changed in the Loadstone, as we see they change in the Earth, one might derive great advantages therefrom as to the Variations of the Magneticall Needle. For if this change of these Poles in the Load-stone were certain, and that it was Analogous to the change of the Poles of the Magnetique Vertue in the Earth, it is not to be doubted but a *Terrella*, being suspended at liberty, would remain immoveable, and that one point thereof would regard the Pole of the World, which might be called the true Pole of the stone, whilest the Poles of its Vertue would pass successively from one part to another, after the same manner as they change in the Earth.

After having well considered this Hypothesis, and having cleared up some doubts which I had, concerning the Position of the Stone at the time when its pole had formerly been determined; I concluded that this former Pole was distant from the point I call the true Pole, thirteen Degrees towards the East, in the place where it had been marked (and which is unknown to me) since that at this time in this Country the Needle Varies about five Degrees Westward.

Upon

Upon this Hypothesis, which I know not that any one else has yet thought upon, I have invented a new sort of Needle for the Compass, which may have the same alterations as a Sphæricall Load-stone, and at the same time the same conveniencies as the ordinary Needle hath.

I caused a Ring of three Inches diameter to be made of Steel Wire ; from which there went three Radii of very fine Brass-wire meeting at the Center in a Cap perfectly like that of an ordinary Compass, that so this Circle might rest on a Pin in its Center, and be at full liberty to turn round, its Center being fixt. This done I gave the Magneticall touch to this Steel Ring, by applying indifferently to a Point thereof one of the Poles of a strong Load-stone, and the other Pole of the Stone to the opposite Point, to give the greater Vertue to the Ring. Then I observed that the Ring was strongly Magneticall, and that the Point called the South Pole did readily turn it self towards the North, and after several Vibrations stopped there; and that it had also the same inclination towards the Pole which is found in Needles after they have been touched : Lastly I fixed upon the Ring a small *Fleur de Lis* of Brass, in the Point which exactly respected the North, the Ring being first well settled.

If the Poles of the Magnetick Vertue change in the Load-stone after the same manner as they do on the Earth ; it seems likely that the same thing should happen to this Ring, and that one Point thereof should always exactly respect the North. But to informe my self if a Steel Ring had the same effects as a *Terrella*, I made the following Experiment. Having touched a Steel Ring, and having laid it on a Paper, I strewed the filings of Steel upon it ; and then gently shaking the Paper, I saw that the direction of the Magneticall matter passed directly cross the Ring from one Pole to the other, and that there were two *Vortices* on the sides, as it is observed in the Sphæricall Magnet ; which seems very surprizing. For

according to the ordinary Hypothesis of the Magnet, the Magnetical Vertue passing more easily in the Steel than in the Air, should run on both sides of the Pole round the Ring, and only form a Pole opposite to the first. But I was further confirmed in this Opinion by applying a flatt and pointed piece of Iron, like the blade of a Knife, to a Load-stone, so as the point of the Iron reached beyond the Stone ; and having afterwards presented this point to the Magnetical Ring, I observed that different Points of this Ring did apply to the Point of the Iron, according as the several parts thereof had been applyed to the Stone: which happens not in the Magnetical Needle, for that always presents one of its ends to the Point of the Iron, being not disposed, by reason of its length, to receive the Magnetical matter in all the parts thereof analogous to those of the Stone. It must only be noted that in an irregular Stone the Magnetical Vertue appears stronger towards the Angles than in the other parts, which may cause some irregularity in this Experiment, if it be tried with a Stone that is very uneven.

These Experiments gave me the Curiosity of making another, by touching two Semi-circles of Steel. Having joyned the two ends touched by the same Poles, I observed by the Steel-dust the same effect as in the Ring. But having joyned the ends differently touched; I found that immediately the two half-rings run together and stuck to each other ; and by the Steel-dust strowed on Paper I observed, that there were four *Vortices*, one in the middle of each semi-circle, and one at each of the places where they were joyned, and that the two latter were less than the others and much stronger. I saw likewise that there were four Poles, each of which was within a *Vortex*, and that each retained in its semi-circle the Vertue of the ends of the half Rings.

I would trie, after having touched a Steel-Wire that was streight, to make a Ring thereof; but I found that it had quite

quite lost its Vertue : which cannot be attributed to the junction of the Poles, since they ought to stick together, according to the other Experiments which have been made ; but only to this that hath been already noted, that when a Magnetical *Virgula* is a little bent, it looses its Vertue, which cannot happen but from the alteration of the Pores of the Steel.

I farther remarked that a Ring of Steel having been touched does for a long time retain its Vertue, although it be put in a position contrary to its Poles. And this Experiment is confirmed by another much more considerable : Which is, that a Ring of Steel having been touched with a strong Load-stone, cannot without difficulty receive a contrary touch from a Magnet less strong than the first ; but that in time by little and little it resumes its former Vertue, much as we see Magnets do, which being applied to another Stone, by the Poles of the same denomination, loose their first Vertue and take a contrary ; which they afterwards loose by degrees, to reassume their first.

After I had presented this new Systeme of the Magnet to the Academy, there were made some Experiments upon a *Terrella* of much the same diameter with mine, but whose Poles were not diametrically opposite ; and upon a half-Globe very much bigger than the *Terrella*. Wee could find in them no considerable difference or alteration of Poles : Yet because of some circumstances, the Company thought fit that some Experiments should be made with this sort of Compass.

If some of these compasses were carried into very remote parts, where it is known that the Magnetical Needle has a great Variation ; one might be certain in little time whether this Hypothesis hold or no, and whether we may expect from it those advantages, which I have concluded from the supposed immobility of a *Terrella* hung at liberty.

It remains only to explain after what manner these circular Needles may be touched a new, when it is perceived that they have lost their first Vigour. According to this Hypothesis, it is evident that if the Circle be not touched in the point that answers to that of the Stone, with regard to its Variation, the little *Fleur de Lis* which marked the true North, may decline a little from it; and the difficulty of finding the corresponding points on the Ring and the Stone, would cause that the touch of the Circle could not be refreshed, without taking great care and first observing the Meridian line. But to avoid all these difficulties, you need only apply the Poles of the Stone to the Ring; and the Ring, which is suspended upon its pivot, will turn so as the Point answering to the Pole of the Virtue of the Stone which is applied to it, will come as near to it as possible: In so much that without touching the one or the other, the Ring will not fail to receive very much force. The same may be done at the opposite Pole.

I doubt not but you are curious enough to see if the poles do change in the *Terrella*, when you shall meet with one fit for this Experiment. There might several other things be noted upon this Subject, and it were to be wished that some other particular observations might be made as opportunity shall offer; but unless curiosities of this nature fall into the hands of such as have a great love for the advancement of the Sciences, it is not to be hoped that we shall have any certain information in a matter so nice,
Et c.

Paris

April. 26. 1687.

This Letter having been produced and Read before the Royal Society; it was Ordered that the *Terrella*, which has been in their Repository these 25 Years, the

the gift of their Royal founder King *Charles* the Second, should be examined, to see if there be any sensible alteration in the Poles thereof: And upon tryal it was found that the Points which are marked thereon with crosses, were as near as could be discerned the true Poles of the Stone; notwithstanding that the Variation has changed at *London* full 4 Degrees since this *Terrella* has been in the Societies Custody; and perhaps many more since it was marked: and had there been a change in the Poles of the Load-stone analogous thereto, it must needs have been perceived in this, whose Diameter is about $4\frac{1}{2}$ Inches. However to put this matter past dispute, care was taken to find out exactly and mark the Poles of the Societys great Load-stone, the Sphere of whose Activity is above 9 Foot Radius, and whose Poles are 13 Inches asunder, whereby if this Translation of the Poles be real, it cannot fail of being made very sensible in future times. As to the supposition that the Points in which the Iron hath received the Magnetical Vertue may change place, after the same manner as the Poles of the Earths Magnetisme are observed to do; tho' it was lookt upon as an ingenious hint and worth prosecution, yet some of the Company, well skill'd in Magneticks were of opinion, rather that such a Circular Needle would librate on its Center, so as to respect the Magnetical Meridian with the Points that had at first received the touch, than that the Ring remaining immoveable, the directive Vertue should be transferred therein from place to place, either by length of time, or by transporting this Compass into those parts where the Variation of the Needle is considerably different.

O'fer-

A Relation of the great effects of a new sort of Burning Speculum lately made in Germany: taken from the Acta Eruditorum of the Month of January last: being a Letter from the Inventor to the Authors of that Journal.

OF the concave burning *Speculum* which I lately caused to be made in *Lusace*, take this following Account.

The like thereof hath not yet been made, *that I know of*, for in Magnitude it exceeds even that great one which they shew as a Sight at *Paris*, and whose measure I took when I was there, by about three eights of a *Lipsick* Ell. The outer Circle of mine is near three such Ells in Diameter, and is made of a Copper Plate scarce twice so thick as the back of an ordinary Knife; and may therefore be easily removed from place to place, and ordered for use; whereas those which I have yet seen that are large, and capable of producing considerable effects, being Cast thick of a Mixt Mettal, are because of their bulk and weight, less Tractable. The workmanship of this *Speculum*, which in one of the other sort, of this Magnitude, would be an immense Labour, may by the contrivances I have invented, be easily and in little time performed by one Man.

The Polish thereof is very good, and represents by distinct reflections all those appearances which arise from the concave Figure thereof; representing a Dwarf like a Gyant, or the Head or other part of a prodigious Magnitude. The Eye being placed nearer the *Speculum* than is the *Focus* thereof, all Objects are seen within it, in
an

an erect Posture, and as at a great distance ; but the Ey being farther off than the *Focus*, all things appear inverted and without the *Speculum* : And becaule the *Focus* is two Ells off, it is pleasant to see Objects distinctly as it were hanging in the Air ; and if a Sword be drawn against the *Speculum*, a Spectator not used to such Optical Delusions, would be apt to be Frighted, Imagining a Pass to be made at his Face.

The Force of this *Speculum* in Burning is such, that even *Chymists*, who best know the power of Fire, will hardly credit it, unless they see it with their own Eyes. For (1) a peice of Wood put into the *Focus* Flames in a Moment, so as a fresh Wind can hardly put it out. (2) Water applyed in an earthen Vessel presently Boyles, so as to Bo yle an Egg, and the Vessel being held there some time, the Water evaporates all away. (3) A peice of Tinn or Lead three Inches thick, as soon as it is put into the *Focus*, melts away in drops, and held there a little time is in a perfect *Fluor*, so as in two or three Minutes to be quite pierced through. (4) A plate of Iron or Steel placed in the *Focus* immediately is seen to be red hot on the backside ; and soon after a hole is Burnt through ; I have made three such holes in a plate, in six Minutes time. (5) Copper, Silver and the like applyed to the *Focus* melt, which I have tryed with several sorts of Coin ; among the rest with a *Rix Dollar*, and the same hapned to it as to the aforesaid Iron Plate in 5 or 6 Minutes. (6) Things not apt to melt as Stones, Brick and the like, soon become red hot like Iron. (7) Slate at first is red hot, but in a few Minutes turns into a fine sort of black Glass, of which if any part be taken in the Tongues and drawn out, it runs into Glass threads. (8) Tiles which had suffered the most intense Heat of Fire, in a little time melt down into a yellow Glass, as do. (9) Pot-threads, not only well burnt at first, but much used in the Fire, into a blackish-yellow Glass. (10) Pumice-Stone said to be that

of

of burning Mountains, in this Solar Fire, melts into a white transparent Glass. (11) A piece of a very strong Crucible put in the *Focus*, in 8 Minutes was melted into a Glass. (12) I have likewise seen Bones turned into a kind of Opake Glass, and a clod of Earth into a yellow or greenish Glass.

It is to be noted that I made these Experiments in the latter end of *August* and *September*, when the Sun has not the same Force as when he is about the Summer Solstice; at which time I promise my self yet more wonderful effects; tho' from hence it is evident, that there is no other Fire in Nature of the like Force and Efficacy.

I might add several other things well worth Notice, but shall only give you this one. I tryed what effect the Beams of the full Moon, concentrated with this *Speculum*, would have, at the time when she was at her greatest Altitude; but there was not found any degree of Heat, tho' the Light was not a little encreased.

This passage of the *Lipsick* Journall was produced at one of the meetings of the Royal Society by Mr. *Hork*, as seconding a proposal he had some Years since made to them concerning the same thing. He supposed that if such a *Speculum* were made of many Foot diameter, its effects must needs be prodigious; and might be of great use in perfecting the Art of Pastes or Factitious Jewells, which require the most intense degree of Heat, to bring them to an exact mixture. He conceives such an one might be made very large for a small Price, being hammered out of a Copper Plate, and tinned over with a mixture of Tin, Lead and Tin-glass, which is found to bear a very good Polish.

L O N D O N

Printed by *J. Streater*, and are to be Sold by *Sam. Smith* at the *Princes Armes* in *St. Pauls Churchyard*.

PHILOSOPHICAL TRANSACTIONS.

For the Months of *September* and *October*, 1687.

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- (1.) **A**N Account of some Saxon Coyns found lately in Suffolk. Communicated by Sir P. S. Fellow of the Royal Society: with some Remarks thereon by Mr. W. W. likewise R. S. Soc.
- (2.) An Estimate of the Quantity of Vapour raised out of the Sea by the warmth of the Sun; derived from an Experiment shewn before the R. Society at one of their late Meetings, by E Halley.
- (3.) Observationes nonnullæ Eclipsæos nuperæ Solaris Maii 1. St. vet. diversis in locis habitæ, ac cum R. Societate communicatæ. *Accounts of Books.* I. *Memoirs for a Natural History of Animals; containing the Anatomical Descriptions of several Creatures dissected by the Royal Academy of Sciences at Paris. Englished by Alexander Pitfield Esquire, R. S. Soc. To which is added an Account of the Measure of a Degree of a great Circle of the Earth, published by the same Academy, and Englished by Rich. Waller, Esq; Reg Soc. Secr. Lond. Fol. 1687.* II. *CONFUCIUS SINARUM PHILOSOPHVS*, sive Scientia Sinensis Latine exposita, Studio & Operâ Patrum Societatis JESU, &c. Adjecta est Tabula Chronologica Sinicæ Monarchiæ ab hujus exordio ad hæc usque tempora. *Parisis. Fol. 1687.*


An Account of some Saxon Coyns found in Suffolk; Communicated by Sir P. S. R. S. Soc.

IN May 1687, at *Honedon nigh Clare* in *Suffolk*, the Sexton, as he was digging a Grave in the Church-yard, met with a Skull; and near it his Spade broke a *Yellow Earthen Pot*, wherein were many Silver pieces of *Saxon Mony*, some of which I have seen, and endeavoured to read the Inscriptions, which are so various, that there are scarce two alike, tho' they are generally of the same bigness, viz. of a Groat, and about the same weight. I ghes this variety of Inscriptions ariseth from the many Masters of the Mint who were appointed to coyn Mony in several Places, and who might each of them have a different Stamp: and I find this Conjecture of mine countenanced by a Passage in *K. Æthelstan's Laws*, Printed by *Lambard*.


Cantuariæ Monetarii VII Sunt, quorum quidem IV Regis, II Præsuli ac unus Canobiarchæ deservito. In Civitate Roffensi tres sint, Regii duo, tertius Episcopi. Londini VIII. Vintoniæ VI. In vico Lewisio II. In vico Hastingso I. Cicestriæ I. Ham-tonæ II. Excestriæ II. Werham II. Schaftsburiae II. Ad aliud quodque oppidum Monetarius unus esto.

To confirm my Opinion, That the several Masters of the Mint made different Reversees, I have observed great variety in *Henry III. Coyn*, viz.

NICOLE  LVND.

WILLEM  LVND.

WILLEM  CINT. *Canterbury quær.*

RICHARD  GLOV.

These Names being probably the Masters of the Mint's, the Laws as to the Mints being not altered. 1 *Hen. VI. Cap. 1.* The King's Council might assign Mony to be Coyned in as many Places as they will. (a)

But now in *France*, tho' there be Mints in several Cities, yet there is no difference in the Inscriptions, only a Letter of the

the Alphabet, to signifie where the Mony is stamp'd; as *A* for *Paris*, &c.

These *Saxon Monies* were *Denarii*, or *Pennies*; for *Greaves*, of the *Denarius*, p. 117. says, In *Ethelred's* time it was the 20th part of the silver Ounce *Troy*, and bigger than three of our present *Pennies*; and our Goldsmiths weigh by this Penny-weight or 24 Grains. Five of the *Saxon Pennies* made a *Shilling*, and (as *Lambard's Glossary* says) therefore 48 of those *Shillings* made a *Pound*, and 240 *Pennies* made a *Pound*, which is the present Proportion of our Penny and Pound, tho' the intrinsic value be about three to one different.

I cannot yet meet with any satisfactory Reason, why this Mony should be thus buried; tho' very probably it was upon a superstitious Account: I shall only offer a bare Conjecture of mine; There were, they say, between 200 and 300 pieces found in the Grave; and if 240, i.e. 1 l. then the Deceased might order so many to be buried with him, as a kind of Expiation for having privately killed a *Dane* of servile Condition; for in *Ethelred's* Law there is this Penalty, *Servilis conditionis Dacum si Anglus morte affecerit, integram solvito Libram*. If more or less was found, it might answer another Mulct enjoined by the *Saxon* Laws for killing or maiming some Person of another Quality. Or the *æstimatio capitis* might be laid in the Grave with the Person that was killed.

Those who believe they were *Peter-Pence*, *Rome-Scot*, *Rome Feoh*, or *Hearth-Penny*, I think are under a Mistake; for that Mony was collected every Year, and carry'd out of the Nation. Nor it cannot be the *Soul Scot* mentioned in *Canute's* Laws, (but first required by the Council or Parliament at *Eanham* in *Ethelred's* time) to be paid at the opening of the Grave, (whence *Sir Henry Spelman*, *De Sepulturâ*, thinks the Fee demanded for the Office of Burial is derived) for it is not likely that Fee or *Soul-Scot* paid to the Priest did amount to the Sum found in this Grave; and it is more unlikely that the Priest should so easily part with his Mony, by burying it.

I shall, as well as I can, give you the Inscriptions on those I saw; viz. Y y 2 On

Reverse

I	ÆDELSTAN RE+	{ P ÑE + + + b F EHO
II	ÆDELSTAN RE+	{ LAND + + + c V EHO
3 wt 23 grains	ÆDELSTAN RE+	{ STEF + + + ANVS
4 24 gr.	ÆDELSTAN RE+	{ AREM + + + d ONETA
5 21 gr.	EADMVND RE+	{ BEN + + + DICTVS
6 16 gr.	EADMVND RE+	{ MAN + + + ANO
7 19 gr.	EADHVND RE+	{ ALB + + + f ERIHG
8	EADMVND RE+	{ IVE H + + + NETA g
9	EADMVN RE+	{ HTIL + + + h HAH
10 24 gr.	EADMVND RE+	{ MERA + + + ATNO
11	EADMVN RE+	{ LITIL + + + WAN
12	EADMVND RE+	{ MAN + + + MANO

On some of these Monies there are very odd *Saxon* Characters, which are not drawn here very exactly. It would be a useful piece of Learning to have an Alphabet of the several Characters or Shapes of Letters observed in antient MSS. Coyns, and Monuments of Stone, &c. and there might be added an Explanation of Words abbreviated, as in these Monies **W** **N**, **U** for M; &c.

Some Pieces are diminished in their Weight, by lying long under ground, and several of them coloured Green. (e)

Spanhemius, in his *Dissertationes de Numismatis*, tells us of the way of Writing Letters backwards, In *Antiquissimis aliquot Græcorum Numismatis*, in quibus **ΣΑΛΗΙ** pro **ΓΕΛΑΣ**; **ΝΟΙΑΤΖΕΙΖ** pro **ΣΕΓΕΣΤΑΙΩΝ**, &c. *aliaq; id genus Phœnicum more sinistrorsum non semel scripta leguntur. Eandem quoque scripturæ rationem in Antiquis aliquot Gothorum Saxi adnotavit Antiquitatis patriæ restaurator Olavus Wormius.* This

13. EADMVND RE +

14. EADHVND REPT +

Edmundi facies
REIHGRHZIOH
+

25. EADMVND RE + { E. R H
O + O
H O

16. 24. gr. EADTVND REX + { IN G E L
+ + +
G A R H

17. 25. gr. EADHYND RE + { G O T A E
+ + +
H O I I E

18. + EADRED RE + 21. gr.
Edredi facies
FREDRED MONETA +

19. + EADRED RE +
Edredi facies
MANEEN INNO +

20. + EADRED +
Edredi facies
ZPERLINL UONE

21. + EADRED REX 24. gr.
Edredi facies
I I A H E C H I N O N E m
+

The same Reverse with the last.

This Reverse is written round the +, whereas most of the Reverses are not so; but there are two Lines of Letters with three Crosses between 'em.

The little o in some of these Monies is periodical.

These following Reverses are written round the +

The **H** is a very clear Character, and stands for a Letter that is not defaced.

Sterling, &c. P. & T. passim confundi Docti observant, πέντε pro πέντε, σολή pro σολή &c. Ruspina pro Rostina, &c. Bochart. Geogr. pag. 450. 706. Denarium & Sterlingum eundem esse Nummum, (Matth. Paril. in Hen. III. tredecim solidis & 4 sterlingis pro Marca

qualibet computatis) Vox ipsa, Sterling, utrum formatur à signo quod imprimebatur isti Nummo, & Sterlingus sit quasi Stellatus, an potius Easterlingus denominatus à Populis, qui Easterlings dicuntur, ambiguum faciunt Scriptores. Gronovius de Sifterniis, pag. 346. (1)

But I find *Gronovius* may be corrected in what he writes in the *Addenda* to the same Treatise by this Reverse; *Dubium non est* (says he) *si Saxonibus Anglis deberetur ea Vox, Sterling, in monumentis illorum repertam iri. — constat inter omnes ante Normannorum ingressum in Angliam, non reperiri mentionem hujus Vocabuli; cum ipso Gulielmo primùm legi, Sterlingos, &c. appellatos, ergò his debetur ea Vox in Anglia.* Yet I believe what he writes just before, *Denariis autem nomen etiam Sterlinges fuisse, in Continente quâ Normanni imperabant, ostendunt duo rescripta Pontificum Romanorum in Decreto Gregorii; and he might well have added, That the Normans borrowed of the Franks that Word Sterling, as well as descriptionem Libræ per solidos denariosque.* But it may be, when *Gronovius* writ, no Coyn or Monument of Antiquity was then discovered in *England* that mentioned *Sterling* before *William I.* whose Name brings to my mind, that on his Coyn *P* is put for *W.* (n)

Sir Henry Spelman, in his Glossary, speaks of *Sterling* and *Denarius* to be the same; and he directs to the Statute made *An. 1302, 31 Edw. I.* wherein the Penny is called *Sterling*, and the weight of the *Sterling* is 32 Grains of dried Wheat; (and I have weighed 32 Grains of Wheat, and they are equal to 24 Grains *Troy-weight*, which is our *Saxon Penny*.) And *Ann. 1496, 12 Hen. VII. Cap. 5,* there is another Statute wherein the *Sterling* is of the same weight.

I am credibly inform'd, some of *Egbert's* and *Ethelbert's* Coyn were found amongst them: Those I saw, were *Æthelstan's*, who began his Reign about the Year 925. *Edmund Etheling's* his Brother, (for I take the *Edmunds* to be his) who began his Reign 940; *Edred*, another Brother, who began his Reign 946.

I hope others more skilful in Antiquities, and that have better advantage by our Records and ancient Histories, will give a clearer Interpretation of the Words, Characters, and other Circumstances relating to these and other *Saxon Monies*.

In the Church-yard at *Foulsham* in *Norfolk*, there is a Tomb-stone with this Inscription, which some of the Learned in these Curiosities may perhaps explain.

On one side	AK	COG	LOO
At one end		OOO	
On the other side	EDÆ	DESWEA	
On the other end		BOG	

*Remarks upon the foregoing Observations by W. W.
Reg. Soc. Soc.*

(a) **T**His Law was in force till *Henry VII.* who, first, that I can find, quartered the Arms of *England* and *France* in his common silver Coyns, on their Reveries: This his Successors have since followed; before they writ, *Civit. London; Civitas Cantuariæ, Villa Calesiæ.* The want of knowing this Custom, has caused some Learned Men to mistake some Coyns of *Edward IV.* with *Civitas Norwic.* on the Reverse, for Medals stamped in memory of *Kett's* Insurrection, by *Edward VI.* Golden Medals, in memory of great Actions, are of ancient use amongst us; witness that golden Coyn of *Edward III.* where a Shield, with the Arms of *England* and *France* over a Ship, is stamped, to shew his Title to the Kingdom of *France*, which he then claimed; yet this can hardly be shewn in silver Coyns which then passed for current Money: that seems to have been peculiar to the *Greeks* and *Romans*, except some Instances in these two last Ages.

The single Exception of *Edward III.* who quarter'd *England* and *France* in his Mony, doth not weaken my Assertion, since it was extraordinary, as a more publick Proclamation of the Justice of that Title, which he set on foot against *Philip de Valois.*

(b) This Reverse is to be read *PENE FEHO*; i. e. Penny-mony, a Duplication usual amongst the *Saxons*; so afterwards
Sterling-

Sterling-mony. *Febo*, or *Feoh*, is a common Word for *Mony*. *St. Mark xii. 41.* þa sæt re hælenð ongen þane tollrceamol, ⁊ gereah hu ꝥ folc hypa feoh; *Then set Jesus over against the Treasury, and saw the People put in Mony.*

(c) *LAND WEHO*; This was coyned in Memory of a Land Tax, raised by *Æthelstan*, to support his Wars against the *Danes* and *Scots*; against whom, especially the *Scots*, he was *always* victorious. Our Writers (*Ingulph. Hist. Croyland. p. 29.*) say that he killed *Constantine* King of the *Scots*, with five more Kings at the same time; but the *Chronicle of Mailrose*, written by the Abbot of *Dundrainand*, a *Scottish-man*, says only, *Regem Scottorum Constantinum prælio vicit, & fugavit*; (*ad An. 926. p. 147.*) And this is the only *Æthelstan* who was ever King of *England*: There was another *Æthelstan* King of *Kent* only, Son to *Egbert*, who beat the *Danes* at *Sandwich* in *Ann. 852.*

The variety of Letters in these Reverses is remarkable: The last Word in these two Reverses is manifestly to be read alike, yet the form of the Letters is vastly different. This variety arose from the multitude of Mints, which did not all tye themselves up to one Stamp, nor to the same Letters.

A R E M (d) This I should read *REgia Moneta*, to distinguish it from the *Bishops* or *Abbots*, for it was
 +++ probably coyned at *Canterbury*; *A*, I take to be a
ONETA. Mint-masters Mark.

(e) Tho' these Coyns, as far as I can judge, are as good Silver as any current with us, if not better; yet since what Alloy is in them is of Brass, I am apt to think, that the acid Steams in a long series of Ages arising from the Humane Bodies, might corrode so far into the Metal, as to raise some little Verdigrease upon the Surface of the Coyns; to which that Greenness is to be imputed.

(f) Probably this *Albericus* was a Nobleman, and they might have had the *Jus monetæ* as well as *Bishops* and *Abbots*; but I must confess I cannot make that out clearly. *H* before *G* is an usual Transposition; so *HCllotharius*, *HLudowicus*.

This

(g) This I read *IVE MONETA*, or *Ive Money*, that is, *Mony* coyned at *St. Ives* in *Huntingdonshire*. The *H*, as also *Π*, both used for *M*, are remarkable. *Bouteroue*, in his *Disquisitions* on the old *French Monies*, gives us some *Gallick* Epitaphs from which he draws an Alphabet of the old *Gauls*: in that, *H* and *Π* are used for *M*; so that possibly the *Britains* might likewise use them: it is manifest they are not *Saxon* Letters; and I see no Absurdity to allow the *Saxons* to have borrow'd them from the *Britains*, and to have used them amongst their own Capitals. There is a Coyn in *Tab. 3. Coyn 14.* of the Collection prefixed before *Ælfred's* Life, which has two other of those *Gallick* Letters of which *Bouteroue* has given us an Alphabet. The Coyn is,

°°° R U I I K	B E R I I E -
Æ L F R E D	+ + +
F I R D K	Π L E D M -
°°°	

The *∞* and *E* are *S* and *F* in his Alphabet; and I am apt to think, that that Inversion of Letters in these *Saxon Monies*, as *U* for *M*, *Π* for *M*, *E* for *F*, took its rise from them; for in this Alphabet we have *Δ* and *∇* for *D*; *∞*, *2*, *Z*, for *S*: however, this will evince, in some measure, the Practice of such Inversions, which made some Learned Men take them for *Runic*, *Gothic*, or indeed for any Characters with which they were little acquainted.

(h) This and the Reverse of the *11*, are to be read alike, tho' they were coyned at different Places, as appears from the variety of the Letters.

(i) *Π* which is used here for *M*, is frequently used in that Collection of *Saxon* Coyns prefixed to *Ælfred's* Life.

(k) This *Gote mone*, or *Gods Mony*, was the *Peter-Pence* which was collected yearly, and sent to *Rome*. *Ina*, one of the Kings of the *Mercians*, first gave it: thence it was constantly
Z z
paid

paid afterwards, tho' now and then intermitted in the heat of the *Danish Wars*, I suppose this Coyn came out of an Ecclesiastical Mint.

(*l*) The true Original of *Sterling* is *Starry*. The Common People observing the Crosses upon the Coyns, which looked like so many Stars, called them *Sterlings*, *Starry* pieces. *Ling* is an adjective Termination in the *Saxon* Language; so in time, the Word became Substantive, and was used promiscuously for Penny.

(*m*) The 19 and 21 Reverses are to be read alike, tho' possibly they might be made from different Stamps. The Letters in both (for neither are very clear) will mutually explain each other. I read it **MALHECH HONE**, or *Malmesbury Mony*: The **H**, which is an entire Letter, seems to have been taken from the square *B*, or **B**.

(*n*) This *P* was the old *Saxon* *p* or *W*; so it was *Willem*, not *Pillem*. The *Saxon* Character, which was full and plain, gave rise to that small beautiful Character which we usually call the *Roman* Letter. The ancient *Romans*, for ought as yet appears to the contrary, wrote all with one uniform Character, sometimes greater and sometimes less, of the same Figure with the great Letters in our Alphabet. This they took from the *Greeks*; and it is usual in all the Alphabets of the Oriental Nations. The three Inscriptions in *Gruter*, (pag. 185. 3. p. 652. 2. p. 882. 7.) only prove that they had our small *t*, *p*, *b*, *h*, for we have no Hints in our MSS. of any others. After them succeeded the *Francick* or *Merovingian* Character, entirely left off in transcribing Books after *Charlemagne*. The Notaries kept it longer; only by making it longer, they brought it to something like the *Italica*, to which it possibly gave rise. The Specimens in *Mabillon's* fourth Book *de re Diplomatica*, will put this past doubt. All this while the *Saxon* Character was used in *England*, whose Alphabet is evidently the same with the small *Roman*, except some Letters which expressed Sounds proper to their Language, as *þ*, *j*, *ð*: wherefore when *Alcuinus* (Scholar to *Egbert* Arch-bishop of *York*.) went over into
France

France to Charles the Great, and afterwards sent for Books out of Egbert's Library, as may be gathered from *William of Malmesbury*, he introduced that fine way of Writing, which immediately took place with all but the Publick Notaries. *Mabillon* owns the thing in effect, tho' he dissembles the Original: *Primâ stirpe extinctâ, Carolus M. Literas expolire cepit, aut certe jam tantisper expolitum Scripturæ genus à Merovinginco in elegantiore formam commutavit, quæ in eandem formam evasit, quæ hætenus minuti Romani Characteris nomen retinet.* (Lib. 1. Cap. 11. num. 10.) And if this Change was not wrought in a moment, because the Transcribers us'd to the old *Merovingian* hand conform'd it to the new, as much as they could, yet that wore off by degrees: so *Mabillon*, quæ [*Carolina Scriptura*] *principio nonnihil Merovingici Characteris habebat intermistum; at subinde politior effecta, in eandem formam, &c.* *Mabillon* acknowledges, that *Alcuin* introduced the modern Punctuation into the *French MSS.* and Records, which he learned from the *Saxons*, particularly [·:] for a full Period, as is manifest to all that shall look into the *Saxon MSS.* or printed Books in imitation of them.

Besides, all our *Latin MSS.* in *England*, 'till some time after the Conquest, were writ in the *Saxon Character*. So Archbishop *Parker* published *Afferius Menevensis*: and there are several *Latin MSS.* in the University-Library of *Cambridge*, written in the *Saxon Character*. And it is no wonder that those Letters which expressed Sounds not used in the *Roman Tongue*, should be left out by the *French Transcribers*, who at the same time might use *Saxon Copies*: so that it is not strange *Vossius* should be mistaken, when he thought Ω and Ð were from the Greek Ω and Θ, who did not consider them to be both *Runic Letters*, which were introduced upon a particular occasion, by *Chilperic*, who took them from the *Visigoths* in *Spain*, as *Wormius* (*de Literaturâ Runicâ*) has probably proved from *Gregorius Turonensis* and a Constitution of the same *Chilperic* printed in *Goldastus*: yet I will not deny but *Theodore*, or some other of those *Greeks*, who in that Age had so

great Intercourse with *England*, might introduce some Greek Letters to express those Sounds which they had not in their own Language ; from hence they were carried into *France*, with the rest of the *Saxon* Alphabet, and so into *Italy*; which *Mabillon* also in effect acknowledges when he says, *Hanc tamen Scripturæ formam non Franci à Romanis, qui Langobardicis passim Elementis tunc utebantur, sed à Francis Romani accepisse videntur*. But it would take up too much time here to discourse of the Original of the *Saxon* Character, and whence those Agreements between it and the pure *Merovingian* and *Lombard* Characters might at first arise ; and perhaps the thing it self does not deserve any farther enquiry.

An Estimate of the Quantity of Vapour raised out of the Sea by the warmth of the Sun ; derived from an Experiment shown before the Royal Society, at one of their late Meetings : by E. Halley.

THat the quantity of aqueous Vapours contained in the *Medium* of the Air, is very considerable, seems most evident from the great Rains and Snows which are sometimes observed to fall, to that degree, that the Water thus discharged out of the Interstices of the Particles of Air, is in weight a very sensible part of the incumbent Atmosphere : but in what proportion these Vapours rise, which are the Sources not only of Rains, but also of Springs or Fountains (as I design to prove) has not, that I know of, been any where well examined, tho it seem to be one of the most necessary Ingredients of a real and Philosophical Meteorology ; and as such, to deserve the consideration of this Honourable Society. I thought it might not be unacceptable, to attempt, by Experiment to determine the quantity of the Evaporations of Water, as far as they arise from Heat ; which, upon Tryal, succeeded as follows.

We

We took a Pan of Water, about 4 inches deep, and 7 inches $\frac{2}{10}$ diameter, in which we placed a Thermometer, and by means of a Pan of Coals, we brought the Water to the same degree of heat which is observed to be that of the Air in our hottest Summers; the Thermometer nicely shewing it. This done, we affixed the Pan of Water, with the Thermometer in it, to one end of the Beam of the Scales, and exactly counterpoised it with weights in the other Scale; and by the application or removal of the Pan of Coals, we found it very easie to maintain the Water in the same degree of Heat precisely. Doing thus, we found the weight of the Water sensibly to decrease; and at the end of two hours we observed that there wanted half an ounce *Troy*, all but 7 grains, or 233 grains of Water, which in that time had gone off in Vapour; tho one could hardly perceive it smok, and the Water were not sensibly warm. This Quantity in so short a time seemed very considerable, being little less than 6 ounces in 24 hours from so small a Surface as a Circle of 8 Inches diameter. To reduce this Experiment to an exact Calculus and determine the thickness of the skin of Water that had so evaporated, I assume the Experiment alledged by Dr. *Edward Bernard* to have been made in the *Oxford Society*, viz. That the Cube foot, *English*, of Water weighs exactly 76 pounds *Troy*; this divided by 1728, the number of inches in a foot will give $253\frac{1}{3}$ grains, or $\frac{1}{2}$ ounce $13\frac{1}{3}$ grains for the weight of a Cube inch of Water; wherefore the weight of 233 grains is $\frac{233}{253\frac{1}{3}}$ or 35 parts of 38 of a Cube inch of Water. Now the Area of the Circle, whose Diameter is $7\frac{2}{10}$ inches, is 49 square inches; by which dividing the quantity of Water evaporated, viz. $\frac{35}{38}$ of an inch, the Quote $\frac{35}{1862}$ or $\frac{1}{53}$ shews that the thickness of the Water evaporated, was the 53^d part of an Inch: but we will suppose it only the sixtieth part, for the facility of Calculation. If therefore Water as warm as the Air in Summer, exhales the thickness of a 60 part of an inch in two hours from its whole Surface, in twelve hours it will exhale the $\frac{1}{10}$ of an inch; which quantity, will be found abundantly sufficient to serve for all the Rains, Springs.

Springs and Dews, and account for the *Caspian* Seas being always at a stand, neither wasting nor overflowing; as likewise for the Current said to set always in, at the Straights of *Gibraltar*, tho those Mediterranean Seas receive so many and so considerable Rivers.

To estimate the quantity of Water arising in Vapour out of the Sea, I think I ought to consider it only for the time the Sun is up, for that the Dews return in the Night, as much if not more, Vapours than are then emitted; and in Summer the Days being longer than twelve hours, this excess is ballanced by the weaker Action of the Sun, especially when rising, before the Water be warmed: so that if I allow $\frac{1}{10}$ of an inch of the Surface of the Sea to be raised *per diem* in Vapours, it may not be an improbable Conjecture.

Upon this Supposition, every 10 square Inches of the Surface of the Water yields in Vapour *per diem* a Cube inch of Water; and each square foot half a Wine pint; every space of 4 foot square, a Gallon; a mile square, 6914 Tons; a square Degree, supposed of 69 *English* miles, will evaporate 33 Millions of Tons: and if the Mediterranean be estimated at 40 Degrees long and 4 broad, Allowances being made for the Places where it is broader by those where it is narrower, (and I am sure I guess at the least,) there will be 160 square Degrees of Sea; and consequently, the whole Mediterranean must lose in Vapour, in a Summers-day, at least 5280 Millions of Tons. And this quantity of Vapour, tho very great, is as little as can be concluded from the Experiment produced: And yet there remains another Cause, which cannot be reduced to Rule, I mean the Winds, whereby the Surface of the Water is lick'd up sometimes faster than it exhales by the heat of the Sun; as is well known to those that have considered those drying Winds which blow sometimes.

To estimate the quantity of Water the Mediterranean Sea receives from the Rivers that fall into it, is a very hard task, unless one had the opportunity to measure their Channels and Velocity; and therefore we can only do it by allowing more than

than enough; that is, by assuming these Rivers greater than in all probability they be, and then comparing the quantity of Water voided by the *Thames*, with that of those Rivers whose Water we desire to compute.

The Mediterranean receives these considerable Rivers; the *Iberus*, the *Rhone*, the *Tiber*, the *Po*, the *Danube*, the *Neister*, the *Boryshenes*, the *Tanaïs*, and the *Nile*, all the rest being of no great note, and their quantity of Water inconsiderable. These nine Rivers, we will suppose each of them to bring down ten times as much Water as the River *Thames*; not that any of them is so great in reality, but to comprehend with them all the small Rivulets that fall into the Sea, which otherwise I know not how to allow for.

To calculate the Water of the *Thames*, I assume that at *Kingston* Bridge, where the Flood never reaches, and the Water always runs down, the breadth of the Channel is 100 Yards, and its depth 3, it being reduced to an equality; (in both which Suppositions I am sure I take with the most.) Hence the Profil of the Water in this Place is 300 square Yards: this multiplied by 48 miles, (which I allow the Water to run in 24 hours, at 2 miles an hour) or 84480 Yards, gives 25344000 Cubick Yards of Water to be evacuated every day; that is, 20300000 Tons *per diem*; and I doubt not but in the excess of my measures of the Channel of the River, I have made more than sufficient allowance for the Waters of the *Brent*, the *Wandel*, the *Lea*, and *Darwent*, which are all worth notice, that fall into the *Thames* below *Kingston*.

Now if each of the aforesaid 9 Rivers yield 10 times as much Water as the *Thames* doth, 'twill follow that each of them yields but 203 millions of Tons *per diem*, and the whole 9 but 1827 millions of Tons in a day; which is but little more than $\frac{1}{5}$ of what is proved to be raised in Vapour out of the Mediterranean in 12 hours time. Now what becomes of this Vapour when raised, and how it comes to pass that the Current always sets in at the mouth of the Streights of *Gibraltar*, is intended, with leave, for a farther Entertainment.

tainment of this Honourable Company: in the mean time, it it needful to advertise the Reader, that in making the Experiment herein mentioned, the Water used, had been salted to the same degree as is the common Sea-water, by the Solution of about a 40th part of Salt.

Observationes nonnullæ Eclipsæ Nuperæ Solaris,
Maii 1. St. vet. diversis in locis habitæ, ac cum Re-
giâ Societate Communicatæ.

HÆC Eclipsis, etiamsi contemnendæ quantitatis fuerit, ac nudis oculis non omnino percipi potuerit, tamen ad accuratam determinationem Parallaxis & Latitudinis Lunæ maxime idonea videtur. Quapropter quas hætenus obtinere potuimus observationes cape Lector Benevole.

Londini seorsim observantibus Hookio & Halleio; Initii momentum, cælo licet purissimo, ob obliquam incidentiam Lunæ, debite definire non licuit. Sed hora 1^h. 16'. jam cæpta erat Eclipsis satis notabiliter: circa 1^h. 40'. prope medium Eclipsis, Chorda partis Eclipsatæ, sive inter cornua, inventa est 9'. 30". cui respondet arcus 36 gr. in diametro vero non nisi 1'. 30". Finis consensu utriusque observatoris contigit accurate hora 2^h. 3'. 00.

Grenovici in Observatorio Regio Flamsteedius eadem de causa Initium non vidit, finem vero determinavit 2^h. 4'. 15". Medio Eclipsis sive maximâ obscuratione, Chorda partis Eclipsatæ erat 9'. 54".

Apud Totteridge prope Londinum versus Corum, finem videt Dominus Haines, Reg. Soc. Soc. ad 2^h. 2'. Quantitatem vero Maximam dimidii Digiti, ab Austro.

In Insula Barbada, ad Oppidum Bridge-Town, sub Lat. 12 gr. 58'. Finem habuit Dominus Frank 1'. 30". temporis ante quam Solis Altitudo fuit 31 gr. 47'. ad ortum, hoc est hora 7^h. 56'. 45". A. M. Quantitatem Maximam æstimatione definivit duorum digitorum ab Austro.

Norim.

Norimbergæ eandem Eclipsim observavit J. P. Wurtzelbaur. Initium quidem accurate ad $1^h. 58' \frac{1}{2}$; circa medium, sc. ad $2^h. 36' \frac{1}{2}$ quantitatem maximam duorum dig. præcise; Finem vero ad $3^h. 18'. 33''$.

Ulmæ Sueviæ, observavit Honoldus Initium ad $1^h. 48'$; Quantitatem maximam $2 \frac{3}{4}$ dig. Finem vero ad $3^h. 16'$.

Lipsiæ, observatore Kirchio, Eclipsis jam satis notabilis ad horam $2^h. 20'. 10''$. ad $2^h. 47' \frac{1}{2}$ digiti $1 \frac{1}{3}$ circiter. Finis vero incidit præcise in $3^h. 15'$.

Vratislaviæ Silesiæ denique observavit D. G. Schultzius Maximam obscurationem, paulo citius quam $3^h. 12' \frac{1}{2}$ fuisse $1 \frac{1}{2}$ dig. Finem vero hora $3^h. 37'$.

In omnibus hujusmodi observationibus momentum Finis multo tutius determinatur; itaque huic potius fidendum est, præsertim in Eclipsibus parvis, ubi ob incidentiam maxime obliquam diu hærent quasi in Contactu Luminaria.

Memoirs for a Natural History of Animals; containing the Anatomical Descriptions of several Creatures, dissected by the Royal Academy of Sciences at Paris; Englished by Alexander Pitfield, Esquire, R. S. Soc. To which is added, An Account of the Measure of a Degree of a great Circle of the Earth: Published by the same Academy, and Englished by Richard Waller, Esquire, R. S. Secr.

THis Book, containing the *Anatomical Observations* of 28 Species of Animals, and about 70 Individuals, was published in two very large *Folio's* by the *Royal Academy* at *Paris*, and owned by them, as their united Labours, as they are a *Body*. The Difficulty of procuring Copies of the *French Edition*, few of the Learned having ever seen the Book, tho' Printed some Years since, was no small Inducement, as the Translators say, to their Undertaking.

Waving what may be said as to their *Preface*, and of the first 12 *Species* of Animals; viz. two *Lions* and a *Lyness*, a *Camelion*, a *Dromedary*, a *Bear*, five *Gazella's* or *Antilopes*, a *Chat Pard*, a *Sea-Fox*, a *Castor*, an *Otter*, two *Civet Cats*, an *Elke*, and a *Coati mondi*, of all which, a large Account has been already given by Mr. *Oldenburg* in his *Philosophical Transactions*, Numb. 49. & 124. to which I refer the Reader; I shall proceed to give some Account of the sixteen remaining *Species*; all which were published in the Second Volumn of the *French Edition*.

The Thirteenth *Species* then is the *Sea-Calf*, which, from *Rondeletius*, they observe to be of two kinds, the larger from the *Ocean*, the lesser from the *Mediterranean*, of which sort this was. That which is most extraordinary in it, was the *Epiglottis*, much larger than in other Animals; its *Ventricle* like an *Intestine*: it had all the *Organs* for *Secretion* of *Urine*, and the *Kidneys* seemed composed of several Glands, each provided with a particular *Pelvis*: it had *Lungs* like other *Amphibious* Animals; and the *foramen Ovale* giving Passage to the Blood from the *Cava* to the *Aorta*. It had the *Cristalline* more convex before, which is not common; and several Particularities in the Formation of the *Eye* favouring the Opinion of the Reception of the visual *Species* on the *Retina*.

The Fourteenth, the *Barbary Cow*, an Animal something resembling a *Deer*: it had but two *Teats*, four *Ventricles* like other ruminating Animals, a very large *Cæcum*, and no distinct *Lobes* in the *Liver*. It was in several Particulars like the common Cow.

The Fifteenth is the *Cormorant*, wherein the shortness of the *Legs* is remarkable, and structure of the *Feet* for swimming with one Foot while the other holds the Prey: the largeness of the *Oesophagus*: want of the two *Cæcums*, found in most Birds: the *Kidneys* separated from the other *Viscera* by a particular Membrane: the *Tongue* and *Eye* very small, this Water-Fowl being to feel for its Food under the Water, rather than discover it from afar.

The

The Sixteenth, the *Chamois* or *Rupicapra*, in whose *Ventricle* a Ball was found; whence they take occasion to discourse of the *Balls* found in the Stomachs of Creatures, as Cows, Horses, &c. and observe that they are compos'd of *lignous Fibreo* and not *Hair*, as is usually thought: besides several other Observables, the *Cornua uteri* were very long and winding; the *Heart* had a *Callous Apophysis*, &c.

The Seventeenth and Eighteenth are the *Porcupine* and *Hedg-hog*, a comparison being made between these two *Animals*. They observe the external *Ear* of the *Porcupine* to be like a *Mans*; the end of the *Tongue* armed as it were with *Teeth*; the *Skin* provided with an extraordinary Muscle for *Ejaculation* of the *Quills*. Of these they dissected six. In comparing the *Hedg-hog* with them, they describe the *Musculus carnosus*, which serves to bring the Head round into the Breech like a Foot ball; whereas in the *Porcupines* the *Cæcum* was very large, in the *Hedg-hog* there was none at all; the *Epididymis*, in the *Porcupine*, was separate from the *Testis*; in the *Hedg-hog* united to it: in the *Hedg-hog* they observed a large *Crystalline* filling almost the whole *Globe* of the *Eye*.

The Nineteenth are four *Monkeys*; where they in general observe, that this *Animal* more resembles *Man* in his outward shape than inward *Formation* of the Parts, which in many things are like a *Dog*; the *genital* Parts of the *Male* like neither; of the *Female* much like *Woman*; the *Anfractuosities* of the *Brain* like *Mans*, but the *Processus mammillares* were hard and membranous, which they are not in *Man*: they conclude with a comparison of the *Muscles*, which very much resemble those of *Men*.

The Twentieth is the *Stag* of *Canada* and *Sardinian Hinde*. In the *Stag*, the length of the *Intestines* is observable, being in all 96 feet; and indeed, generally all *grazing Animals* have long *Guts*. In the *Hinde*, the four *Ventricles* were more distinguishable than in the *Stag*; the *Cornua uteri* long and winding, as in the *Chamois*: in the Trunks of the *Jugulars* were found 16 *Valves*, which were in situation contrary to the *Cir-*

culatation of the Blood. In the *Carotides* were observed several transverse *Incisures*.

The Twenty first, ten *Pintadoes*; where, after a full description of the outward Form, they describe several Parts like the common *Hen*; the *Pancreas* wanting: the *Bladders* in the lower Belly were raised by blowing into the *aspera Arteria*, whence they hint at the use of *Respiration*.

The Twenty second, three *Eagles*: after having discoursed of the six kinds of *Eagles*, according to *Aristotle* and *Pliny*; they observe, That the *Intestines*, after the usual manner of voracious Animals, were slender and short, as also the *Kidneys*; some had the *Cæcum*, others none: the Globe of the *Eye* was large, and the *Cornea* very prominent. In this Subject they first discovered that the *Spinal Marrow* in the middle of the Back was divided in two, with a *Ventricle* like those in the *Brain* betwixt: this was afterwards found common to all *Birds*.

The Twenty third, two *Indian Cocks*, not our *Turkey Cocks*. They were both Males: in one there was two *Pancreas*'s, with three *Cholidoci*, and two *Pancreatici ductus* into the *Intestine*: in the other was but one *Pancreas*, and a single *ductus*: the *Intestines* were 12 feet long, and *Cæcum* six: the *Aspera Arteria* made a fold in the *Craw-bone*, after a most particular manner.

The Twenty Fourth, six *Bustards*; in which the *Craw* was scarce distinguishable from the *OEsophagus*, and furnished with a great number of *Glands* most conspicuous in this, but to be found in most *Birds*: a particular description of the *Gizzard* follows, and of a third *Cæcum* near the *Rectum* or the *Bursa Fabricii*: between the *Cornea* and *Sclerotica* a cartilaginous Circle was observed. They end with the discovery of a black *Purse* in the *Eyes* of *Birds*.

The Twenty fifth, six *Demoiselles* of *Numidia*, a kind of Crane, in which they found the *Liver* very large, and without *Gall-bladder* in some Subjects. In the Female a kind of Gland besides the *Ovary*, resembling the *Testicles* of the Male. Amongst other Observables, the Structure of the *Wind-pipe* was very unusual, entering with a winding into the Bone of the

the *Sternum*: at its Union with the *Lungs* it had a kind of *Larynx*: the *Punctum Lachrymale* in the *Eye* was double, &c.

The Twenty sixth, eight *Ostriches*, in which they very largely discourse of the make of the *Feathers* of Birds, and joyning of the *Fibres* of each Feather to one another; a great part of which, seems to have been taken out of Mr. *Hook's* ingenious Book of *Microscopical Observations*, tho' they have not thought fit to own it. The *Foot* of this *Animal* seems contrived for a speedy Course, in which its *Wings* are of great use: the different length of the *Intestines* is observable, in some being 50, whereas in another they were but 29 feet; the *Cæcum*, which was double, was wreath'd like a *Screw*, and the inside of the *Colon* provided with Valves or semilunar leaves, like *Membranes*. At the extremity of the *Rectum* was found a *Bladder* filled with *Urine*. In this Description they discourse largely of the *Ureters* and genital Parts of *Birds*, as likewise of the *Lungs*, and its Divisions or *Diaphragmes*, and its Communication with the *Bladders* containing the *Ventricle* and *Intestines*: together with the manner and use of *Breathing* in *Birds*, explaining it by a pair of double *Bellows*, &c.

The Twenty seventh, the *Cassowar*, a Bird but lately known to the *Europeans*: it has no *Quills* nor *Feathers* for flying, and indeed but short *Wings*: that which was most unusual was the want of a musculous *Gizzard*, tho' a *granivorous Animal*; which might in some sort be supplied by the number of *Ventricles*. In this Subject they more particularly insist on the *Muscles* of the *Thorax* necessary for *Respiration*, and a curious description of the Parts of the *internal Eye lid* in *Birds*, as to its *Mechanism* and *Use*.

The Twenty eighth. They conclude these *Discourses* with that of a very large *Land Tortois*, being four foot and $\frac{1}{2}$ from the extremity of the *Head* to the *Tail*. Amongst the *Internal Parts*, the Structure of the *Urine Bladder* is very curious for its *exterior Tunicle* being *membranous*: the inside was strengthened with an infinite number of *musculous Fibres*, not unlike those in the *Ventricles* of the *Hearts* of *Animals*. This Contrivance

seems necessary for the pressing out of the *Urine* in this *Animal*, which has an unyielding *Belly*, not capable of *Compression*; nor was the *formation* of the *Heart* less observable: it had three *Ventricles* communicating with each other by *holes* in the *Septum*: the *Vena Cava* had two *Branches* into two of the *Ventricles*, which likewise received *Blood* from two *Venæ pulmonares* to be transmitted to the *Aorta*, &c. Having been already too large, I shall pass by what was observed of the extraordinary *Structure* of the *Lungs*, with a *Discourse* of the *Lungs* of *Animals* in general, which they reduce to three *sorts*;

An Experiment to this purpose made by Mr. Hook. Vid. Ph. Tr. n. 28. p. 539.

treating next of *Respiration*, together with an *Experiment* of blowing up the *Lungs* of a *Dog* with a pair of *Bellows*; but I shall refer, as to the other *Particulars* in this and the former *Anatomical Discourses*, to the *Book* it self, very well deserving the *Perusal* of all *Persons* curious in *Anatomy* and *Chirurgery*, containing many useful *Remarks* and natural *Discoveries*, of which this is but a very imperfect *Account*.

I shall say nothing of the *Measure* of the *Earth* added to the end of this *Edition*, a very full *Account* having been given of it in the *Philos. Transf.* Numb. 112. to which I refer the *Reader*: only the *Translators* thought fit to annex it, the *Curiousness* of its *Subject*, and exceeding *Scarcity*, being sufficient to recommend it to this *Learned* and *Inquisitive* *Age*.

Confucius Sinarum Philosophus, sive Scientia Sinensis
Latine exposita, Studio & Operâ Patrum Societatis
JESU, &c. Adjecta est Tabula Chronologica Sinicæ
Monarchiæ ab hujus exordio ad hæc usque tempora.

THE famed *Chinese* *Philosopher* CUM-FU-CU, or as we call him *Confucius*, being in so great esteem in his own *Nation*, and having never yet appeared in an *European* *Dress*, cannot but be gratefully received by the *Curious*, especially since the *Version* is performed

ed by very ancient Missionairs sufficiently accomplished in the knowledge of the *Chinese* Character, and at the Command (as is said) of the King of *France*.

The Subject of this Book being foreign to our purpose, as consisting chiefly of Moral and Political Precepts and Apophthegmes of the Philosopher, I shall not enlarge thereon; only to recommend it, the Translators assure, That the Memory of the Author is still precious in *China*; and that in respect to *him*, his Posterity, after above 2200 Years, enjoys certain great Privileges never granted but to the Royal Family; is exempt from all Taxes; and whosoever is advanced to the Degree of Doctor, gives, as a mark of his Respect to the great *Confucius*, some Present to the eldest of his Family, who is now 68 Generations removed from him.

As to the time when *Confucius* lived, 'tis here precisely set down from the *Chinese* Annals: He was born *Anno* 551. *ante Christum*, and lived 73 Years; so that he was contemporary with the most ancient Greek Philosophers, and not long after *Pythagoras*, flourishing about the time of *Tarquinius Superbus* and the first Consulats, when *Darius Hystaspis* held the *Persian* Empire. He is said to be descended of a Branch of one of the most ancient Royal Families, which might not a little contribute to gain Respect and Credit to his Writings.

But what may not improperly find place here, is, the *Chinese* Chronology, whereof such wonderful Relations have been brought into *Europe*: This Matter the Author of this Part of the Book, *P. Couplet*, seems well to have examined, and to have sifted the credible from the fabulous. They begin their Account with the Years of the Reign of King *Fohi*, who was the Founder of their Empire, about the Year before Christ 2952; rejecting, as ill grounded, and not to be believed, all that some Authors have said of the Times before, and following therein the Opinion of the best reputed *Chinese* Historians. This *Fohi* is said to have reigned 115 Years, and to have invented the Character now in use in *China*, and his Successor *Xin-nun* is made to govern 140 Years: These two Kings are by our Author, by reason of some manifest Fables in their History, reputed doubtful; wherefore they, as from a more certain *Era*, choose to begin their Annals with the third King *Hoam-ti*, and the Year before Christ 2697. This *Hoam-ti* is said to have instituted the Sexagenary Cycles or Periods of 60 Years, according to which this Chronology is adjusted, and for want of which, or the like, our Account of Time, both Sacred and Profane, is subject to too great Uncertainties; the Years of the Reigns of Kings, where the Months and Days are neglected, introducing great Errors in length of time, which

which by this method are prevented. Since this Institution, there are now 73 Periods elapsed, and the 74 is current ; in which time they account that there has been 234 Kings of *China*, sprung from no less than 22 several Royal Families; the King now reigning being the second of the Race of the *Tartars*, who within these 50 Years have thoroughly subjected *China*.

In this Chronology are set down the beginnings of each Kings Reign, with a short Character of the Prince, and the principal of his Acts, with the most notable Contingencies of his time : amongst the rest, several Eclipses of great Antiquity are recorded, whereby this account may be examined.

The third King, *Chuen-bio*, is said to be the Author of the *Chinese* Kalendar, and to have appointed the beginning of the Year to be on the New-Moon next the beginning of the Spring, which the *Chinese* account to be when the Sun is in 5 gr. of *Aquarius*: this Account is now in use, tho' instituted 2500 Years before Christ. About 700 Years after, the King *Chim-tam* reduced the beginning of the Year to the Winter Solstice; but the former was restored about 100 Years before Christ, and still continues.

The Years of this Account are Luni-solar, or consisting of 12 Lunar Months, half of 30 days, and the rest of 29 days, with the Intercalation of 7 mon. in 19 years; so that 7 years in each Cycle have 13 mon. This Distribution of mon. was ordained by K. *Yao*, above 2300 years *ante Christum*, and is, if rightly intercalated, a more exact measure of the Coelestial Motions than our *Julian* Account or old Style, for that fails a day in 131 years, whereas this Account of the *Chinese* (which is nearly the same with the *Jewish*) fails but a day in 225 years, or 4 days in 900 years; but since their method of Intercalation is not here expounded, I shall not say more in a matter of such Uncertainty.

'Tis here said, that the famous Wall of *China*, extending above 400 Leagues, was begun by King *Xi-Hoam-ti* about the year *ant. Chr.* 210. to hinder the Incurfions of the *Tartars*, which in all Ages have infested this Country. The following Cycles are more amply described, and towards the End, the Transactions of the *Romish* Missionaries are inserted, with a brief account of that great Revolution in *China*, by the entire Conquest of that Kingdom by the *Tartars*. This Chronology ends with the year of Christ 1683, being the last of the 73^d Cycle, since the King *Hoamti*; and contains in all 4380 years.

'Twill be needless to advertise, that this Account places the beginning of the *Chinese* Empire long before the *Deluge*, according to the Holy Scriptures; wherefore if this be to be wholly rejected, as fabulous; or if not, how it is to be reconciled with the sacred Chronology, belongs more properly to the Disquisition of the Divines.



PHILOSOPHICAL TRANSACTIONS.

For the MONTH of NOVEMBER. 1678.

The CONTENTS.

(1.) **D**E SESTERTIO Dissertatiuncula, sub finem Voluminis Quarti opusculorum Celeberrimi D. D. *Isaaci Barrow*, S. S. *Theologiæ Professoris* nuper edita, Cum Tabula valorem Nummi Romani in moneta Nostra *Angliæ* exhibente. Quam ob eximium ejus usum in legendis veteribus ex loco quodammodo improprio huc transferre visum est.

(2.) *De Numero Radicum* in *Æquationibus Solidis* ac *Bi-quadraticis*, five *tertiæ* ac *quartæ Potestatis*, earumq; limitibus, ex contemplatione intersectionum Circuli & *Parabolæ* datæ in *Constructionibus* hujusmodi *æquationum tractatulus*.
Authore *E. Halley*.

(3.) An Account of some Observations lately made at *Nuremburg*, by Mr. *P. Wurtzel-baur*; shewing that the Latitude of that Place, has continued without sensible alteration for 200 Years last past; as likewise the Obliquity of the *Ecliptick*; by comparing them with what was observed by *Bernard Walther*, in the Year 1487: Being a Discourse read before the *ROYAL SOCIETY*, in one of their late Meetings.

B b b

DE

DE SESTERTIO Dissertatiuncula ex Opusculis
Posthumis Viri Celeberrimi D. D. Isaaci Barrow
nuper editis decerpta.

GAssendus pecuniam Gallicam confert cum multis sester-
tii nummi: Supponit autem denarium, Sestertii quadru-
plum, sub primorum Cæsarum temporibus octavam uncie par-
tem æquasse pondere: quam hypothesis aliquatenus redarguit
noster Gravius: (De Den. pag. 96, & 113.) probat enim sub
illis, qui Vespasiano priores imperarunt Cæsaribus, varium &
inconstans denarii pondus extitisse; majus scilicet & minus al-
ternatum, sæpius tamen decrescendo, ita ut ab Augusto ad Vespasi-
anum decreverit a septima parte uncie ad partem octavam; in
quo ferme statu perstitit a Vespasiano ad Alexandrum Severum.

Unde consequi videtur ad lectionem veterum authorum magis
conducere, ut moderni nummi cum Consulari denario (recentiore
nimirum) comparentur, tum quoniam is statim certique ponderis
fuit (uncie septimam partem adæquans) tum quia tempus, quo
in usu fuit, plerosque comprehendit poetas & historicos nobili-
ores, tum quia verisimilius est præcipuos auctores ad hunc potius
respexisse, quam ad Cæsarium illum mutabilem & nullo certo
pondere definitum. Pag. 119.

Denarium vero Consularem noster Gravius (Pag. 61. 94, &c.)
ex appensis multis denariis, ex eorundem cum aliis aureis argen-
teisque nummis (Romanis, Hebræis, Grecis, Persicis, &c.)
collatione, & ex Vespasiani congi mensura deducit cum LXII
granis Anglicis æquiponderare. (Pag. 81.) Unde cum denarius
noster octo grana pendat, Consularis iste denarius valebit septem
denarios nostros cum tribus quartis. At denarius Cæsareus,
 $\frac{1}{8}$ uncie pondus habens, pendet $54\frac{1}{4}$ grana, valebitque denarios
 $6\frac{1}{32}$.

Breerwoodus autem denarium Consularem ($\frac{1}{7}$ uncie penden-
tem) æstimat denariis nostris $8\frac{4}{7}$; & Cæsareum ($\frac{1}{8}$ uncie) dena-
riis $7\frac{1}{2}$: quæ magna est a Gravio discrepantia. Sed is non vi-
detur Romana pondera cum nostris accurate contulisse.

In eo quoque graviter errare videtur idem Breerwoodus, quod Cæsareum denarium Atticæ drachmæ putat æqualem : cum huic potius æquetur denarius Consularis ; imo quum exquisitius rem pensitando Attica drachma etiam Consularem denarium (tanto majorem Cæsareo) 5 gravis Anglicis exsuperet, ut luculente probat Gravius. Pag. 72.

Consultius itaque visum est a Gravio adsertis proportionibus adherere ; Et cum Consulari nummo pecunias nostras conferre. Quibus ex suppositis adjuncta tabella computatur.

Tabula valorem Nummi Romani in moneta nostra
Angliæ exhibens.

	Lib.	Sol.	Den.	ob. 2 ^æ .	Q. 4 ^æ .	C. 8 ^æ .	16 ^æ
II S. Sestertius. 2 ½ Æris.	1	000	00	01	I	I	0
	2	000	00	03	I	I	I
	3	000	00	05	I	I	0
X Denarius. 10 Æris.	4	000	00	07	I	I	0
	5	000	00	09	I	0	0
	6	000	00	11	I	0	0
	7	000	01	01	0	0	0
	8	000	01	03	I	0	0
	9	000	01	05	0	I	0
	10	000	I	7	0	I	I
	20	000	3	2	0	3	0
	30	000	4	10	0	0	I
Centum æris 10 Denarii.	40	000	6	5	I	0	0
	50	000	8	0	0	3	I
	60	000	9	8	0	I	0
	70	000	11	3	I	0	I
	80	000	12	11	0	0	0
	90	000	14	6	0	I	I
	100	000	16	I	0	3	
	200	001	12	3	I	0	
	300	002	8	5	0	I	
Mille æris. 100 Denarii.	400	003	4	7	0	0	

		lb.	ol.	pen.	Q. 4 ^æ .
	500	4	0	0	0
	600	4	16	10	2
	700	5	13	0	1
	800	6	9	2	0
	900	7	5	3	3
Sestertium.	1,000	8	01	05	2
	2,000	16	02	11	0
	3,000	24	04	04	2
Decem millia æris, 1000 Denarii.	4,000	32	05	10	0
	5,000	40	07	03	2
	6,000	48	08	09	0
	7,000	56	10	02	2
	8,000	64	11	08	0
	9,000	72	13	01	2
	10,000	80	14	07	
	20,000	161	09	02	
	30,000	242	03	09	
Centum millia æris, 10,000 Denarii.	40,000	322	18	04	
	50,000	403	12	11	
	60,000	484	07	06	
	70,000	565	02	01	
	80,000	645	16	08	
	90,000	726	11	03	
Sestertium semel	100,000	807	05	10	
bis	200,000	1614	11	08	
ter	300,000	2421	17	06	
&c.	400,000	3229	03	04	
	500,000	4036	09	02	
	600,000	4843	15	00	
	700,000	5651	00	10	
	800,000	6458	06	08	
	900,000	7265	12	06	

De Numero Radicum in *Æquationibus Solidis ac Biquadraticis*, sive tertiæ ac quartæ potestatis, earumq; limitibus, tractatulus Authore *E. Halley*.

CUM in tractatulo, quem nuper publici juris feci in actis hisce Philosophicis, Num. 188; Methodum aperuissem, qua Problemata solida utcumq; affecta minimo negotio, unica data Parabola & Circulo, simplicissime construi possint; sub finem mihi sese obtulit contemplatio jucunda satis, nempe ex his Constructionibus Numerum radicum in quavis *Æquatione*, earumq; Limites ac signa facile consequi ac determinari: quocirca fidem dedi me brevi de hac materia dissertatiunculam aliquam scripturum, in qua si non Principibus, saltem secundæ classis Geometris, me non ingratum nec inutile præstiturum omnino persuasum habui.

Propius vero inspicienti mihi compertum est, me imprudentem inter ardua Geometrica illapsum, ac jam iis tractandis designatum, quibus olim laboravere Viri illustres Harriottus nostras, ac Cartesius; in quibus pari fato utriq; Paralogismum, (forsan in eorum scriptis Geometricis unicum) diverso tamen modo, admisere; uti posthac probabitur: sed Quandoq; bonus dormitat. Qua propter agnita rei tum difficultate tum præstantia, totis viribus incumbere statui, ne promissis exequendis impar crederer, ac ne Geometriæ pars tam eximia, tamq; parum culta, diutius tenebris involuta lateret; sed ope nostra lucide his paucis exposita daretur.

Imprimis vero Lectorem monitum velim, quod dum his legendis operam dat, oportet prædictam dissertationem Num. 188. editam, ad manum habere, ac Constructiones ibidem traditas probe callere; quia quæ sequuntur ab illis maxima ex parte pendent, quas tamen hic repetere vix integrum esset.

Ex Cartesio & ex ibi dictis constat, tam in Cubicis quam in Biquadraticis æquationibus, radices exponi posse demittendo perpendicularia in Axem, datamve diametrum Parabolæ datæ, ab intersectionibus Curvæ illius cum Circulo. Cumq; Circulus Parabolam secans, vel in quatuor vel duobus punctis eam interfecare necesse est, constat in Biquadraticis vel duas vel quatuor radices veras, Affirmativas vel Negativas, semper haberi; uti etiam si forte Circulus illam tangat, quo in casu æqualitas duarum radicum ejusdem signi concluditur. In Cubicis autem, quoniam una ex intersectionibus ad Constructionem requiritur, non nisi una vel tres reliquæ radices designant unam vel tres; uti in Casu contactus, unde constat duas æquales reperiri Radicis, Problemaq; unde resultat æquatio revera planum esse.

Cubicæ itaq; omnes quomodocunq; affectæ una vel triplici radice explicabiles sunt, utiq; semper possibiles, nempe si radices Negativas pro veris admiseris: sic Biquadraticæ, quarum terminus ultimus x signo — affecta est, duabus vel quatuor. Ast si habeatur $+x$ in æquatione, eaq; tanta sit, ut $\sqrt{GD^2 - ar}$, (vide fig. pag. 341.) minor sit quam ut Circulus, eo Radio ac centro G descriptus, Parabolam contingere in aliquo puncto possit, æquatio data omnino impossibilis est, nec ulla Radice Negativa vel Affirmativa explicabilis: Sed de his plura in sequentibus.

Quoniam vero tanta intercedit differentia inter casus Cubicarum & Biquadraticarum, ut simul comprehendi nequeant; primum Cubicas deinde alteras tractabimus. Cubicæ vero infinitis Circulis in data Parabola construuntur, Biquadraticæ autem unico tantum (saltem his methodis): id adeo quia ponendo $z = e$ sive indeterminata aliqua, æqualem nihilo, æquatio Cubica reducitur ad Biquadraticam easdem radices cum Cubica habentem, atq; insuper aliam ipsi e æqualem; unde fit ut tot Circulis diversis construi possit Cubica, quot imaginari velis quantitates e , id est infinitis. Inter has vero Constructiones illa, quam dedi (pag. 342.) longe facillima est. Huic tamen non multum cedit alia, quæ ad enucleationem Numeri Radicum, earumq; limitum

tum magis accommodata videtur, quæq; ortum trahit ex ablatione secundi termini, ponendo modo vulgari $x=z +$ vel $-$ tertia parte Coefficientis termini secundi. Hæc autem est. Data Parabola ABY (Fig. I.) ejusq; Vertice A , axe AE & Latere recto a , reducatur æquatio ad formam consuetam, viz. $z^3. bz^2. apz. aaq. = 0$. Deinde ad distantiam $\frac{1}{3}b$ ducatur Axi parallela BK , dextrorsum quidem si fuerit $+b$, aliter sinistrorsum, Parabola occurrens in B ; ac lineæ suppositæ AB erigatur perpendicularis utrinque interminata DP , axi occurrens in puncto G . De B in Axem demitte perpendicularum BC , & ipsi AC fiat GE semper æqualis, ac versus inferiora ponatur. Ab E fiat $EH = \frac{1}{2}p$, sursum quidem, si in æquatione fuerit $+p$, deorsum vero si $-p$, ac e puncto H (vel ex E si defuerit quantitas p) educatur perpendicularum HQ interminatæ DP occurrens in puncto O . Denique in lineæ HQ interminata, fiat $OR = \frac{1}{2}q$, ab O dextrorsum si fuerit $-q$, sinistrorsum si $+q$, collocanda: ac Circulus centro R , radio RA descriptus, tot punctis secabit Parabolam, quot æquatio proposita veras habet radices; eaq; erunt perpendiculara ZY a punctis intersectionum Y in axi parallelam BK demissa; quarum quæ ad dextram lineæ BK Affirmativæ sunt, ad sinistram Negativæ.

Hujus Constructionis commoditas in eo consistit, quod circulo per Verticem transeunte peragitur, perinde ac si defuisset secundus Terminus; ideoq; ad Radicum Numerum determinandum, sufficit Loci sive Lineæ Curvæ proprietates perspectas habere, quæ spatia discriminat, ubi si ponatur centrum Circuli qui per Parabolæ Verticem transeat, circumferentia ejus vel uno vel tribus aliis punctis eam secabit; hoc est Lineæ curvæ, in quam incidunt centra omnium Circulorum per verticem transeuntium ac deinde Parabolam tangentium, naturam definire.

Locus autem ille est Parabolis, quam cum Cl. Wallisio semicubicalem appellare licet, sive in qua Cubi applicatorum ad Axem sunt inter se ut Quadrata portionum Axis. Cujus Latus rectum est $\frac{27}{8}$ Lateris recti datæ Parabolæ, Vertex vero punctum V (Fig. I.) existente AV dimidium lateris recti ejusdem Parabolæ. Hoc est, si ponatur Unitas pro latere recto datæ Para-

bolæ, $\frac{8}{27}$ cubi ordinatim applicatæ æquabuntur quadrato partis diametri, sive cubus ex $\frac{2}{3}$ V H quadrato ex H R, si scil. R sit centrum circuli qui per verticem Parabolæ transeat eamq; deinde contingat; Hæc est Curva illa quam primus mortalium Nelius Nostras rectæ datæ æqualem demonstravit, eaq; occasione apud Principes Geometras dudum celebris; ejusq; proprietates Cl. Wallisius sub finem Libri de Cissoide, & Hugenus prop. 8 & 9 de linearum Curvarum evolutione, aliq; acri ingenio disquisivere, Quorum scripta consulat Lector. Hæc Curva utrinq; ab Axe Parabolæ descripta, viz. V N L, V P X, spatium complectitur, in quo si ponatur centrum Circuli, qui per verticem A transeat, interfecabit ille Parabolam in tribus aliis punctis; Spatia vero ab Axe remotiora centra præbent circulis non nisi uno præter verticem puncto Parabolam secantibus.

His probe intellectis jam ad determinandum Radicum numerum accingimur: Ac primum deficiat secundus terminus; sitque Latus rectum 1, vel $A V = \frac{1}{2}$; In constructione V H est $\frac{1}{2}$ p, H R vero $\frac{1}{2}$ q; cumq; si fuerit + p, ab V versus superiora ponendo sit $\frac{1}{2}$ p, centrum circuli extra spatium L V X semper constituitur; ideoq; una tantum radice explicabilis est, affirmativa si $-q$, negativa si + q: quæ quidem radices Cardani Regulis investigantur. Si vero fuerit $-p$, V H = $\frac{1}{2}$ p inferne ponitur, ac fieri potest ut H R cadat inter Axem & Curvam V X vel V L, si scilicet Cubus ex $\frac{2}{3}$ V H, sive ex $\frac{1}{3}$ p, major sit quam quadratum ex $\frac{1}{2}$ q, sive $\frac{1}{4}$ p p p major quam $\frac{1}{4}$ q q, quo in casu tres dantur radices, duæ Negativæ, si fuerit $-q$, ac una Affirmativa earum summæ æqualis; vel si + q, duæ Affirmativæ unaq; Negativa. Quod si $\frac{1}{27}$ p p p minor sit quam $\frac{1}{4}$ q q, una tantum reperitur Radix, Affirmativa si $-q$, negativa si + q. Atq; hæc passim docentur ab iis qui hanc Geometriæ partem tractarunt.

Jam adsint omnes termini, ac primum proponatur, Exempli causa, æquatio hæc $z^3 - z^2 b + z p - q = 0$; cui etiam Figuram I. adaptavimus. In hujus constructione B C = $\frac{1}{3} b$, V G = $\frac{1}{2}$ A C = $\frac{1}{6} b b$, V E = $\frac{1}{6} b b$, V H = $\frac{1}{6} b b - \frac{1}{2} p$, G H = $\frac{1}{6} b b - \frac{1}{2} p$ vel $\frac{1}{2} p - \frac{1}{6} b b$, hinc H O = $\frac{1}{27} b^3 - \frac{1}{6} b p$ vel $\frac{1}{6} b p - \frac{1}{27} b^3$, atq; H R sive distan-

tia

tia Centri circuli R ab Axe, est semper differentia inter $\frac{1}{2}b p$ & $\frac{1}{27}b^3 + \frac{1}{2}q$; quæ si æquantur, centrum cadit in Axe; si $\frac{1}{2}b p$ major sit quam $\frac{1}{27}b^3 + \frac{1}{2}q$ ad sinistram Axis, sin minor ad dextram. Si itaq; Cubi ex $\frac{1}{2}VH$, (hoc est ex $\frac{1}{2}b b - \frac{1}{3}p$ quam nominemus d) Latus quadratum sive $\sqrt{d d d}$, majus sit quam HR, sive differentia inter $\frac{1}{27}b^3 + \frac{1}{2}q$ & $\frac{1}{2}b p$; reperitur centrum R intra spatium NPV, Paraboloidibus VPX, VNL ac recta interminata DNP circumscriptum: ac proinde circulus Parabolam secabit in tribus punctis Y, Y, Y, ad dextram lineæ BK sitis, atq; adeo æquatio tres habet radices Affirmativas. Centro vero extra hoc spatium NVP constituto, non nisi una radice Affirmativa explicari potest. Hic obiter notandum rectam DP Paraboloidem VPX tangere in puncto P, existente EP $\frac{1}{27}b^3$; alteram vero VNL secare in puncto N, ita ut demisso in axem Perpendicularo NF, VF sit pars quarta ipsius EV sive $\frac{1}{4}bb$, NF vero $\frac{1}{108}b^3$. VW autem, quæ e puncto V axi perpendiculariter erecta lineæ DP occurrit in W, æqualis est $\frac{1}{34}b b b$ sive $\frac{1}{2}EP$.

Hinc tuto concluditur si in æquatione vel p major sit quam $\frac{1}{3}b b$, vel q major quam $\frac{1}{27}b^3$, non nisi unam eamq; affirmativam radicem reperiri; Fallit itaq; Regula Cartesii (Edit. Amst. 1659 pag. 70) ubi tot veras dari radices quot sunt in æquatione mutationes signorum + & — pronunciat, frustra etiam in Commentariis suis Sphalma hoc excusante Schootenio; Fingi enim possunt infinite plures æquationes præcedentis formulæ tres signorum mutationes habentis, quæ unam tantum quam quæ tres habeant radices. Propositio etiam quinta Sectionis quintæ Artis Analyticæ Harriotti Nostri, uti Prob. 18 Numerosæ Potest. Resol. Vietæ, vix satis firma est, cum ex limitati- onibus quas ibi posuerunt, toti parallelogrammo PIVW id conveniat, quod soli spatio NVP jam competere probavimus, hoc est ut centrum præbeat circulo tribus aliis punctis præter verticem Parabolam secante.

Quantitas autem q, sive terminus ult., datis b & p, ea lege ut p minor sit quam $\frac{1}{3}bb$, accurate limitatur ex præcedente æquatione $\sqrt{d d d} = \frac{1}{27}b^3 + \frac{1}{2}q$ & $\frac{1}{2}b p$; cum scil. Circulus Parabola-
D d d lam

lam contingat. Itaq; $\frac{1}{2}q$ minor esse debet quam $\frac{1}{2}b p - \frac{1}{27}b^3 + \sqrt{ddd}$; at si p major fuerit quam $\frac{1}{2}b b$, maiorem etiam esse oportet $\frac{1}{2}q$ quam $\frac{1}{2}b p - \frac{1}{27}b^3 - \sqrt{d^3}$ ne cadat centrum in spatulo $N V W$: Atq; his conditionibus æquatio semper triplici radice explicabilis erit, aliter non nisi una. Semper vero, sive tres sive una, Affirmativæ sunt, ob positionem centri R ad dextram lineæ $D P$.

Atq; hic est casus maxime difficilis, ita ut quicumq; præmissa bene calleat sequentia facili negotio intelliget. Detur jam æquatio $z^3 - b z^2 + p z + q = 0$. Hic ut tres habeantur radices, oportet centrum circuli alicubi intra spatium $P N \Delta$, rectis $P N$, $P \Delta$ & curva Paraboloidis $N \Delta$ definitum, reperiri; quapropter cum $E F$ sit $= \frac{1}{2}b b$, p minor esse debet quam $\frac{1}{2}b b$; jam ad determinationem quantitatis q , existente $d = \frac{1}{2}b b - \frac{1}{3}p$ ut antea, $\sqrt{ddd} + \frac{1}{27}b b b - \frac{1}{2}b p$ semper major esse debet quam $\frac{1}{2}q$, ut constituatur centrum circuli in spatio prædicto $P N \Delta$: quod cum sit æquatio talis duas habet radices Affirmativas ac unam negativam. Si vero p major est quam $\frac{1}{2}b b$, vel $\frac{1}{2}q$ major quam $\sqrt{ddd} + \frac{1}{27}b b b - \frac{1}{2}b p$, non nisi una eaq; negativa radice explicabilis est.

Proponatur jam æquatio $z^3 - b z^2 - p z - q = 0$. Ut hæc æquatio tres habeat Radices, oportet centrum circuli alicubi inveniri in spatio indefinito, inter rectam $D P D$ & curvam Paraboloidis $P X$; hic quantitas p non est obnoxia limitationibus, $\frac{1}{2}q$ vero semper minor esse debet quam $\sqrt{ddd} - \frac{1}{27}b b b - \frac{1}{2}b p$, posito $d = \frac{1}{2}b b + \frac{1}{3}p$: Hoc pacto duæ dantur Radices Negativæ, ac una Affirmativa; aliter vero si $\frac{1}{2}q$ major sit quam $\sqrt{ddd} - \frac{1}{27}b b b - \frac{1}{2}b p$, unica tantum Affirmativa exponi potest. Quarto loco sit æquatio $z^3 - b z^2 - p z + q = 0$, quæ duas Affirmativas habet Radices ac unam Negativam si centrum circuli reperiat in spatio indefinito inter rectas $P \Delta$, $P D$ ac curvam Paraboloidis ΔL ; hoc est, (posito $d = \frac{1}{2}b b + \frac{1}{3}p$), si $\frac{1}{2}q$ minor sit quam $\sqrt{ddd} + \frac{1}{27}b b b + \frac{1}{2}b p$; si vero $\frac{1}{2}q$ major hac quantitate fuerit, una tantum Negativa inest radix.

Quatuor autem æquationes reliquæ, in quibus habetur $+b$, quoad limitationem Numeri Radicum non differunt a prædictis, si signum

num termini ultimi mutetur, servato signo termini tertii; quæ vero Affirmativæ erant radices in illis hic fiunt Negativæ; & vice versa. Sic in æquatione $z^3 - bz^2 + pz^2 - q = 0$. Una vel tres erant Affirmativæ Radices; in hac vero $z^3 + bz^2 + pz + q = 0$ vel una vel tres Negativæ sunt, sub iisdem conditionibus; nulla vero omnino Affirmativa. Sic in $z^3 + bz^2 + pz - q = 0$, duæ sunt Negativæ & una Affirmativa, si p minor sit quam $\frac{2}{3}b$, ac $\frac{2}{3}q$ minor quam $\sqrt{d^3 + \frac{2}{27}b^3} - \frac{1}{3}bp$, quemadmodum in $z^3 - bz^2 + pz + q = 0$ duæ erant Affirmativæ & una Negativa; excedentibus autem leges præscriptas p vel q , una tantum hic est radix Affirmativa, quæ ibi Negativa erat. Pari modo in $z^3 + bz^2 - pz + q = 0$ vel duæ sunt Affirm. ac una Neg. vel una Negativa tantum. Deniq; iisdem de causis in æquatione $z^3 + bz^2 - pz - q$ duæ sunt Negativæ & una Affirm. vel una Affirm. tantum, quibus in æquatione $z^3 - bz^2 - pz + q$ duæ erant Affirm. & una Negativa, vel una Negativa tantum, nempe prout $\frac{2}{3}q$ major vel minor fuerit quam $\sqrt{d^3 + \frac{2}{27}b^3} + \frac{1}{3}bp$.

Si defuerit terminus tertius, sive pz , centrum R semper cadit in linea $IP\Delta$, quocirca si fuerit $z^3 - bz^2. * - q$ vel $z^3 + bz^2. *. + q$, una tantum esse potest radix, si $-b$ Affirmativa, si $+b$ Negativa. At si fuerit $z^3 - bz^2. *. + q$ vel $z^3 + bz^2. *. - q$, duæ possunt esse Affirmativæ ac una Negativa in priore, vel una Affirm. & duæ Neg. in posteriori, cadente centro in linea $P\Delta$ inter P ac Δ , hoc est si $\frac{2}{3}q$ minor sit quam $\frac{2}{3}b^3$; sin major fuerit, una tantum Negativa in priore, vel una Affirm. in posteriore dari potest.

Hactenus numerum radicum in Cubicis æquationibus plenius assecuti sumus, restat ut nonnulla adjiciam de quantitate radicum. Hic primum notandum quod omnis æquatio tres habens radices ope Tabulæ Sinuum, Trisectione scilicet anguli, satis expedite resolvi possit; ponendo scil. $\sqrt{\frac{2}{3}bb} - p$ vel $\sqrt{4d}$, si fuerit $+p$ in æquatione, vel $\sqrt{\frac{2}{3}bb} + \frac{1}{3}p$, si $-p$, pro Radio Circuli; Angulum vero trisecandum qui Sinum habeat in Ta-

bula Sinuum $\frac{\frac{2}{3}b^3 + \frac{1}{3}bp + \frac{1}{3}q}{\sqrt{ddd}}$ Invento hoc angulo, Sinus

tertiæ partis ejus, ut & Sinus terciæ partis compl. ad Semicirculum, eorumq; summa, ex Tabula Sinuum dabuntur. Hi vero Sinus in Radium $\sqrt{\frac{1}{2}bb + p}$ ducendi sunt, & habebuntur quantitates (y &, y &, y &, in Fig.) quarum & $\frac{1}{2}b$ vel summa vel differentia, prout casus postulat, veras radices Aequationis exhibebunt. Hac omnia ex inventis Cartesii derivantur: Ut vero casus omnes quantum fieri possit breviter complectar, dico quod centro R, in prima æquationum formula, cadente in spatio VGP, sectiones duæ Y, Y, cadunt inter A & B, ac proinde utraq; ex minoribus radicibus minor est quam $\frac{1}{2}b$, tertia autem & major semper superat $\frac{1}{2}b$, superatur vera a b. Quod si cadat in spatio GNV, duæ majores sunt quam $\frac{1}{2}b$, minores vero quam $\frac{1}{2}b$, tertia vero est b — duabus alteris, ac proinde minor quam $\frac{1}{2}b$: sed adhibita limitatione quantitatis p, ætioribus terminis radicis includuntur. Maxima enim radix minor est quam $\sqrt{\frac{1}{2}bb - \frac{1}{2}p} + \frac{1}{2}b$, major vero quam $\sqrt{\frac{1}{2}bb - \frac{1}{2}p} + \frac{1}{2}b$; at cum $\frac{1}{2}bb$ minor est quam p, limes ille fit $\sqrt{\frac{1}{2}bb - \frac{1}{2}p} + \frac{1}{2}b$. Radix media semper minor est quam $\sqrt{\frac{1}{2}bb - p} + \frac{1}{2}b$; major vero quam $\frac{1}{2}b - \sqrt{\frac{1}{2}bb - \frac{1}{2}p}$; hunc vero limitem nunquam excedit radix minima, sed cum quantitate q evanescit.

In secunda formula præscriptis legibus duæ sunt affirmativæ ac una negativa, ac cadente centro in spatio GPE altera ex affirmativis major est, altera minor quam $\frac{1}{2}b$, major vero non excedit b, Negativa autem major non esse potest quam $\sqrt{\frac{1}{2}bb} - \frac{1}{2}b$, est autem differentia ipsius b & summæ Affirmativarum. Centro autem in spatio ENG \triangle posito, utraq; Affirmativa major est quam $\frac{1}{2}b$, minor vero quam $\sqrt{\frac{1}{2}bb} + \frac{1}{2}b$, Negativa vero semper minor est quam $\frac{1}{2}b$. Limites autem proprios ex data p evadunt, radicis quidem maximæ Affirmativæ $\sqrt{\frac{1}{2}bb - p} + \frac{1}{2}b$, qua semper minor est, ut & major quam $\sqrt{\frac{1}{2}bb - \frac{1}{2}p} + \frac{1}{2}b$; hoc tamen limite minor est altera Affirmativa, quæ cum quantitate q minuitur. Negativa vero semper minor est quam $\sqrt{\frac{1}{2}bb - \frac{1}{2}p} - \frac{1}{2}b$, ac deficiente quantitate q evanescit.

In tertia formula duæ Negat. sunt ac una Affirmativa: in hac,
ut &

ut & in quarta, Radices non limitantur a quantitate b. Affirmativa vero semper minor est quam $\sqrt[3]{\frac{4}{3}bb + \frac{4}{3}p + \frac{1}{3}b}$, major tamen quam $\sqrt[3]{p + \frac{4}{3}bb + \frac{1}{3}b}$: maxima vero ex Negativis semper major est quam $\sqrt[3]{\frac{4}{3}bb + \frac{1}{3}p - \frac{1}{3}b}$, minor vero quam $\sqrt[3]{p + \frac{4}{3}bb - \frac{1}{3}b}$. Minor autem ex Negativis semper minuitur cum minuta quantitate q.

In quarta formula, cadente centro intra spatium L Δ P D; si duæ sint Affirmativæ ac una Negativa, maxima ex Affirmativis major esse nequit quam $\sqrt[3]{p + \frac{4}{3}bb + \frac{1}{3}b}$, nec minor quam $\sqrt[3]{\frac{4}{3}bb + \frac{1}{3}p + \frac{1}{3}b}$; minor vero radix ab hoc limite minuitur, minuta quantitate q. Negativa autem minor est quam $\sqrt[3]{\frac{4}{3}bb + \frac{4}{3}p - \frac{1}{3}b}$; major vero quam $\sqrt[3]{p + \frac{4}{3}bb - \frac{1}{3}b}$.

Notandum vero hic radices Negativas ubiq; signo Affirmativo notari, quia hæc sunt radices Affirmativæ quatuor æquationum illarum, in quibus habetur + b, ac q signo contrario notatur; ut supra monui. Horum omnium demonstratio ex eo consequitur, quod ubicunq; centrum circuli R incidit in Lineas Curvas V P X vel V Δ L, circumferentia ejus Parabolam tangit in puncto, cujus distantia ab axe est $\sqrt[3]{\frac{2}{3}VH}$, eamq; secat ex altera Axis parte, ad distantiam $2\sqrt[3]{\frac{2}{3}VH}$; cum vero centrum cadit in lineam D P D, altera ex radicibus fit = 0, ac proinde Cubica reducitur ad Quadraticam, sive ad $z^2 - bz + p = 0$ cujus radices limites designant ubi evanescit quantitas q: ac quo minor est q, eo propius ad has limites accedunt radices. Quadratica est etiam cum centrum cadit in Axe; hoc est, cum $\frac{1}{2}q = \frac{1}{8}bp - \frac{1}{27}b^3$ in prima formula; vel $\frac{1}{2}q = \frac{1}{27}bbb - \frac{1}{6}bp$ in secunda; in tertia impossibile est; at in quarta cum $\frac{1}{2}q = \frac{1}{27}bbb + \frac{1}{6}bp$; quo in casu minor ex Radicibus Affirmativis est $\frac{1}{3}b$, major $\sqrt[3]{\frac{1}{3}bb + p + \frac{1}{3}b}$; Negativa vero $\sqrt[3]{\frac{1}{3}bb + p - \frac{1}{3}b}$. In prima, Radices sunt $\frac{1}{3}b$ & $\frac{1}{3}b \pm \sqrt[3]{\frac{1}{3}bb - p}$. In secunda vero formula, $\frac{1}{3}b$ & $\sqrt[3]{\frac{1}{3}bb - p} + \frac{1}{3}b$ sunt Affirmativæ: Negativa autem $\sqrt[3]{\frac{1}{3}bb - p} - \frac{1}{3}b$.

Atq; hæc in Cubicis sufficere posse videntur; ob eximium vero Usus Methodi, qua ope Tabulæ Sinuum radices harum æquati-

onum inveniuntur, placuit unum vel alterum exemplum adjungere, ut praxis illius compendium inde innotescat. Proponatur Aequatio $z z z - 39 z z + 479 z - 1881 = 0$; quærentur radices z . $\sqrt{\frac{1}{2} b b - \frac{1}{3} p} = \sqrt{9 \frac{1}{3}} = \sqrt{d}$, cujus duplum $\sqrt{37 \frac{1}{3}}$ radius est Circuli; & $\frac{\frac{1}{27} b b b + \frac{1}{2} q - \frac{1}{3} b p}{\sqrt{d d d}} = \frac{2197 + 940 \frac{1}{2}}{9 \frac{1}{3} \sqrt{9 \frac{1}{3}}}$

$= 3113 \frac{1}{2}$, sive $\frac{24}{9 \frac{1}{3} \sqrt{9 \frac{1}{3}}}$ est sinus Tabularis Anguli, hoc, est, facta divisione ope Logarithmorum, Log. 9.9251560, cui respondet, Angulus 57gr. 19m. 11s. $\frac{1}{2}$. Hujus tertia pars 19g. 6m. 24s. & complementi 40g. 53m. 36s. Sinus dant Log. 9.514983. & 9.816011, qui ducti in Rad. $\sqrt{37 \frac{1}{3}}$ producunt Y &, & Y & Log. 0.301030 = 2 & Log. 0.601059 = 4, tertia vero Y & æqualis est eorum summa sive 6. Ideoq; radices sunt $13 - 4 = 9$. $13 - 2 = 11$ & $13 + 6 = 19$, ex quibus singulis conflatur prædicta æquatio. Ubi Notandum duas minores radices non excedere $\frac{1}{2} b$ vel 13, quia centrum R in constructione cadit ad dextram Axis; id est $\frac{1}{2} b p$ minor est quam $\frac{1}{27} b^3 + \frac{1}{2} q$.

Exemplum alterum sit $x^3 - 15x^2 - 229x - 525 = 0$. & quærantur radices. $\sqrt{\frac{1}{2} b b + \frac{1}{3} p} = \sqrt{101 \frac{1}{3}} = \sqrt{d}$; & Radius Circuli $\sqrt{405 \frac{1}{3}}$. $\frac{\frac{1}{27} b^3 + \frac{1}{3} b p + \frac{1}{2} q}{\sqrt{d d d}} = \frac{125 + 572 \frac{1}{2} + 262 \frac{1}{2}}{101 \frac{1}{3} \sqrt{101 \frac{1}{3}}}$

$= \frac{960}{101 \frac{1}{3} \sqrt{101 \frac{1}{3}}} = \text{Sinui Tabulari Arcus, cujus Log. 9.9736426,}$
& Arcus ipse 70gr. 14m. 22s. hujus pars tertia est 23gr. 24m. 47 $\frac{1}{2}$ s. & complementi 36. 35. 12 $\frac{1}{2}$; quorum Sinus Log. sunt 9.599183 & 9.775275, quibus addito Log. $\sqrt{405 \frac{1}{3}}$ sunt Log. 0.903089 = 8 & Log. 1.079181 = 12, & eorum summa = 20. Hinc concluditur $20 + \frac{1}{3} b$ vel 25 æquari radici Affirmativæ, & 8 & 12 $- \frac{1}{3} b$ sive 3 & 7 Negativis. Quod si æquatio fuisset $x^3 + 15x^2 - 229x + 525 = 0$, 3 & 7 fuissent Affirmativæ; 25 vero Negativa. Ceteræ autem Cubicæ unica tantum Radice explicabiles juxta Regulas Cardani resolvendæ sunt, postquam demptus fuerit secundus terminus; nec video quo pacto minori calculo hoc negotium peragi possit. At si desideretur radix hæc in Quantitatibus b, p, q expressa, dico eam

eam esse in prima formula, $\sqrt[3]{b} + \text{vel} - \text{summa vel differentia Radicum Cubicarum ex } \sqrt[3]{\frac{1}{4}qq - \frac{1}{108}p^2 b^2 + \frac{1}{27}b^3 q - \frac{1}{8}b p q + \frac{1}{27}p^3 \pm \frac{1}{27}b^3 + \frac{1}{2}q - \frac{1}{6}b p}$: viz. +, si $\frac{1}{27}b^3 + \frac{1}{2}q$ major sit quam $\frac{1}{8}b p$, aliter —; Summa vero quoties $\frac{1}{6}b b$ major est quam p ; sin minor fuerit $\frac{1}{6}b b$, differentia. Inq; cæteris formulis radix semper conflatur ex iisdem elementis, variatis tamen signis + & —, ut facile percipiet qui velit experiri.

Ope vero Tabulæ Logarithmicæ Sinuum Versorum Radices hæc satis prompte inveniuntur; nempe si Coefficientes Numeri sint Surdi vel fracti, ac radices Numeris ineffabiles; ut plerumq; sit. Hæc autem est Regula: In prima ac secunda formula, si $\frac{1}{6}b b$ minor sit quam p ; sit $\frac{1}{3}p - \frac{1}{9}b b = d$, & posita differentia inter $\frac{1}{8}b p$ & $\frac{1}{27}b^3 + \frac{1}{2}q$, hoc est HR , in prima, ac inter $\frac{1}{8}b p + \frac{1}{2}q$ & $\frac{1}{27}b^3$, in secunda, pro Radio; inveniatur angulus cujus Tangens est $d \sqrt{d}$. Deinde ut Co-sinus hujus anguli, ad ejusdem Sinum versum: ita differentia pro Radio habita, ad quartum; cujus Latus cubicum trisecando Logarithmum habebitur: ac diviso $\frac{1}{3}p - \frac{1}{9}b b$ per hoc Latus Cub. e Quoto subducatur Divisor: Residuum erit quantitas $Y \&$, in Fig. I. Hujus Residui ac $\frac{1}{6}b$ summa, si centrum cadit ad dextram Axis, aliter differentia earundem, Radix erit quæsitæ. Quod si $\frac{1}{6}b b$ major sit quam p , posito HR pro Radio, sit $d \sqrt{d}$ sive distantia Paraboloidis ab Axe, Sinus Arcus cujusdam; Hujus Sinus versus ducatur in Radium, sive $\frac{1}{8}b p - \frac{1}{27}b^3 + \frac{1}{2}q$, ac trisectione producti Logarithmo, habebitur ejus Latus Cubicum, per quod dividatur $\frac{1}{6}b b - \frac{1}{3}p$. dico Quoti ac divisoris summam eadem Lege additam vel ablatam ex $\frac{1}{6}b$, Radicem quæsitam exhibere. Ac par est ratio in tertia ac quarta formulis, nisi quod $\frac{1}{27}b b b + \frac{1}{6}b p \pm \frac{1}{2}q$ pro Radio assumenda est, ac $\frac{1}{9}b b + \frac{1}{3}p$ in $\sqrt[3]{\frac{1}{9}b b + \frac{1}{3}p}$ sive $d \sqrt{d}$ pro Sinu: Sed hæc præcepta exemplis fortasse melius percipientur.

Sit æquatio Cubica $z z z - 17 z z + 54 z - 350$, ac quæ-ratur Radix z : Hic $\frac{1}{6}b b$ major est quam p , sed q major est quam Cubus ex $\frac{1}{6}b$, ideoq; una tantum Affirmativa Radice explicabilis est. Jam $\frac{289}{9} - \frac{54}{3}$ est d , ac $\frac{127}{9} \sqrt[3]{\frac{127}{9}}$ pro Sinu habenda est, ad Radium $\frac{4913}{27} + 175 - 153$, hoc est $\frac{5507}{27}$:

Arcus vero competens fit 15gr. 3m. 49s. Hujus Sinus Versi Log. 8.5362376. additus Log. Radii 2.3095913. dat. 0.8457-889. cujus tertia pars 0.2819276. est Log. Radicis Cubicæ 1.91394, quo divisore diviso $\frac{127}{9}$ sive d, fit Quotus 7.37281; Quoti ac divisoris summa, aucta additione $\frac{1}{3}b$, fit Radix quaesita, nempe 14.9534, &c.

Exactis Cubicis Biquadraticas jam aggrediamur; Hæ semper vel nullam, vel duas, vel quatuor Radices veras habent, quarum determinatio partim a Coefficientibus, partim a signo & magnitudine numeri absoluti dati, pendet; Harum omnium Constructionem generalem (in N^o. 188. Pag. 341) satis concinnam prodidi, quam Lector jam vidisse supponitur; Figuram tamen eo spectantem (Fig. II.) huc transferre visum est. In Constructione equationis $z^4 - bz^3 + pz^2 - qz + r = 0$, fit $BD = \frac{1}{4}b$, $AB = \frac{1}{16}bb$, $BK = \frac{1}{2}$, sive dimidio Lateris recti, $KC = 2 AB = \frac{1}{8}bb$. $KE = \frac{1}{8}bb - \frac{1}{2}p$, $AE - \frac{1}{2} = \frac{1}{16}bb - \frac{1}{2}p$ $FE = \frac{1}{16}b^3 - \frac{1}{4}bp$, ac $EG = \frac{1}{16}b^3 - \frac{1}{4}bp + \frac{1}{2}q$; quo facto Circulus centro G, Radio $\sqrt{GD^2 - r}$, intersecabit Parabolam vel nullo, duobus aut quatuor punctis, quæ perpendicularis in lineam DH, Radices omnes z exhibent. Ut autem quatuor sint, evidens est centrum circuli alicubi constitui debere intra spatium, de cujus puncto quovis tria perpendiculara in Curvam Parabolæ demitti possint; atq; simul radium minorem esse maximo ex illis perpendicularibus, majorem vero medio. Quod si centrum constituatur extra hoc spatium, ut non nisi una perpendicularis in Parabolam demitti possit, qua major sit radius; vel si minor sit media ex tribus perpend. major vero quam minima ex illis, duæ tantum possunt esse radices; nulla vero omnino datur, quoties radius $\sqrt{GD^2 - r}$ minor est minima ex tribus, vel una illa, quoties una tantum est.

Jam quale spatium hoc sit, quibusq; limitibus discernitur, ac quibus conditionibus radius Circuli minor vel major sit prædictis perpendicularibus, nobis restat inquirendum; ac primum quo pacto perpendicularis in Parabolam demitti possit ostendendum est.

Sit ABC Parabola, AE Axis ejus, AV (Fig. III.) semi-Latus rectum, G punctum de quo demittenda est perpendicularis: Ducatur Axi perpend. GE, ac bisecetur VE in F, & erecta perpend. FH ad idem Axis Latus, fiat $FH = \frac{1}{4}GE$; dico quod Circulus, Centro H, radio HA descriptus, Parabolam interfecabit in punctis tribus vel uno Z; ad quæ ductæ rectæ GZ Curvæ Parabolicæ perpendiculariter insistant.

Ut autem tres sint hujusmodi intersectiones, oportet centrum circuli H ita collocari, ut sit intra spatium Paraboloidibus (in Fig. I.) inclusum; hoc est ut FH minus quam $\sqrt{\frac{8}{27}}VF^3$ sive FH^2 minus quam cubus ex $\frac{2}{3}UF$: atq; adeo $GE = 4FH$ minor erit quam $4\sqrt{\frac{8}{27}}VF^3$ sive $4\sqrt{\frac{8}{27}}VE^3$, hoc est quadratum ex GE minor erit quam $\frac{16}{27}VE^3$. Coincidunt itaq; hi limites cum Paraboloidibus duabus ejusdem generis cum iis quibus in Cubicis usi sumus, sed quarum Latus rectum duplo minor est; viz. $\frac{27}{16}$ Lateris recti Parabolæ, hoc est $\frac{27}{8}$ ipsius AV: ideoq; ea ipsa est linea Curva cujus evolutione generatur Parabola, sic demonstrante Hugenio; quamq; semper contingit linea DF, (Fig. II.) quæ Parabolæ perpendiculariter insistit in puncto D. Punctum autem P, sive in quo contingit recta DF Paraboloidem, centrum est Circuli, qui radio DP descriptus cum Parabola in puncto D coincidit, sive ejusdem Curvitatatis est; ut per se satis constat.

Descriptis itaq; hujusmodi Paraboloidibus VXP, VNΔ (Fig. II.) utrinq; ab Axe; perspicuum est quod, nisi centrum Circuli constituatur intra hos limites, non possit ille pluribus quam duobus in punctis Parabolam interfecare: unde determinare licet quibus sub conditionibus Coefficientes terminorum intermediorum coercentur, in æquationibus Biquadraticis, ut habeantur quatuor radices. Ac prima fronte clarum est p majorem esse non posse quam $\frac{1}{6}bb$ (scil. in formulis ubi habetur + p) nec q quam $\frac{1}{6}b^3$. Generaliter vero $\frac{1}{6}b^3 \mp \frac{1}{4}pb \mp \frac{1}{2}q$, id est distantia centri ab Axe EG, minor esse debet quam $EH = 4\sqrt{\frac{1}{27}}VE^3$, hoc est (ob $VE = \frac{1}{6}bb \mp \frac{1}{2}p$) quam $\frac{1}{6}bb \mp \frac{1}{3}p\sqrt{\frac{1}{6}bb} + \text{vel} - p$; signis + & — in dubio relictis, ut secundum æquationis cujusvis naturam variari possint; quem-

admodum in Cubicis superius ostensum est; ac nollem doctis tædium injicere, aut discentibus singula particulatim rimandi voluptatem ac exercitationem præripere.

Termini autem ultimi & limitatio eadem facilitate inveniri nequit; id adeo, quia Problema sit Solidum, in Curvam Parabolæ demittere perpendicularem, quodq; non sine solutione æquationis Cubicæ resolvi possit. Itaq; prima loco deficiat secundus terminus, vel si adfuerit, tollatur, ut æquatio habeat formulam $z^4. * . p z^2. q z. r. = 0$. Ac si fuerit $-r$, semper duabus vel quatuor Radicibus explicari potest; ut autem quatuor sint, oportet centrum circuli intra Paraboloides prædictas constitui, sive ut sit $-p$, ac $q q$ minus quam $\frac{8}{27} p^3$ sive cubo ex $\frac{2}{3} p$. Deinde habeantur radices æquationis hujus $y^3. * . \frac{1}{3} p y. \frac{1}{4} q = 0$, quantitatibus p & q iisdem signis annexis quibus in Biquadratica. Hæ autem Radices auxilio Tabulæ Sinuum satis expedite inveniuntur. Inventis autem tribus illis y , (quæ sunt ordinatim applicatæ ad Axem Parabolæ, de punctis ubi incidunt perpendiculara in Curvam ejus. scil. ZY in Fig. III.) $p y y - 3 y^4$ ex minore y , quantitatem maximam r designabit, si fuerit $-r$; qua si minor fuerit r , æquatio quatuor habebit radices, aliter duas. Ast si fuerit $+r$, oportebit eam minorem esse quam $3 y^4 - p y y$ ex media y , nam si major sit, non nisi duas habere potest radices, saltem si minor sit r quam $3 y^4 - p y y$ ex maxima y . Hac vero si major sit, nulla omnino radice vera explicabilis est æquatio. Hi vero iidem limites aliter designantur ex quantitate q , scil. $\frac{1}{2} q y - y^4$ in primo casu, $y^4 - \frac{1}{2} q y$ in secundo, ac $y^4 + \frac{1}{2} q y$ in tertio.

Fieri autem potest ut duæ minores quantitates y non longe distent ab invicem, unde evenit quod utraq; ex perpendicularibus major sit quam recta GA , scil. cum $q q$ majus sit quam $\frac{4}{27} p^3$, minus vero quam $\frac{8}{27} p^3$; cadente centro intra spatium Paraboloidibus utriusq; Figuræ I & II interjectum. Hoc in casu, si fuerit $+r$, non nisi duæ possunt esse radices, existente $y^4 + \frac{1}{2} q y$ ex maxima y , major quam r ; aliter nulla. At si $\frac{1}{2} q y - y^4$ ex minima y , major fuerit quam r signo $-$ notata, r vero major quam $\frac{1}{2} q y - y^4$ ex media y , tunc habentur quatuor radices

dices; at duæ tantum si vel major priore vel minor posteriore inventa sit r.

Si vero in æquatione fuerit $+p$, vel si sit $-p$ & q majus fuerit quam $\frac{8}{27}p^3$, æquatio y^3 . *. $\frac{1}{2}p y$. $\frac{1}{4}q$ unica tantum explicatur radice y ; hoc est una tantum perpendicularis de centro Circuli demitti potest: unde certo concluditur duas tantum radices haberi posse in æquatione data, quarum summa, si fuerit $-r$, cum quantitate r augetur; at si habeatur $+r$, obtenta quantitate y , quantitas illa r minor esse debet quam $y^4 + \frac{1}{4}q y$; nam si ea major sit, æquatio proposita absurda & impossibilis est.

Longum & superfluum esset omnes hujus census æquationes percurrere, cum ex jam dictis attendenti satis evidens sit, quæ Negativæ, quæ Affirmativæ sint; atq; quod Radicum harum Limites ex quantitatibus inventis y petantur. In exemplum vero, quod cuivis in cæteris imitari licet, proponantur indagandi limites sive conditiones, sub quibus in Æquatione Biquadratica 4 Radices Affirm. dari possint. Hoc autem fit quoties centrum circuli G ponitur in spatio UPK , (Fig. II.) ac simul habetur $+r$ sive Circuli radius minor quam GD : Unde patet, æquationem de qua agitur hujus esse formulæ $z^4 - bz^3 + pz^2 - qz + r = 0$; p vero majorem esse non posse quam $\frac{3}{4}bb$, nec $\frac{3}{4}pb$ hoc in casu, quam $\frac{1}{16}b^4 + \frac{1}{4}q$; deinde opus est ut $\frac{1}{4}pb - \frac{3}{8}p$ in $\sqrt{\frac{1}{16}bb - \frac{1}{8}p}$ major sit quam $\frac{1}{16}b^4 + \frac{1}{4}q - \frac{1}{4}pb$; & ex his limitibus certo constabit centrum intra spatium UPK inveniri. Ut vero definiatur quantitas r , solvenda primum est Cubica y^3 . *. $-\frac{3}{16}b^3 - \frac{1}{2}p y = \frac{1}{32}b^3 + \frac{1}{4}q - \frac{1}{2}p b$; & habebuntur puncta, in quæ perpendiculares de centro in Curvam Parabolæ cadunt.

Inventis autem tribus valoribus hujus y , r minor esse debet quam $\frac{3}{256}b^4 + \frac{1}{4}b q - \frac{1}{16}b b p + 3y^4 - \frac{3}{8}b^2 y y + p y y$ ex media y , major vero quam $\frac{3}{256}b^4 + \frac{1}{4}b q - \frac{1}{16}b b p + 3y^4 - \frac{3}{8}b^2 y y + p y y$ ex minima y . Hos vero limites si excedat r , non nisi duæ Radices haberi possunt. Deniq; si $\frac{3}{256}b^4 + \frac{1}{4}b p - \frac{1}{16}b b p + 3y^4 - \frac{3}{8}b b y y + p y y$ ex maxima y , minor fuerit quam r , æquatio proposita impossibilis est.

Accidit etiam ut quatuor sint Affirmativæ, cum Centrum G constituitur in spatiolo V T S; ducta scil. R T S perpendiculari in medium suppositæ lineæ AD: Hoc autem fit cum p major est quam $\frac{1}{16}bb$, ac $\frac{1}{4}bb - \frac{1}{3}p \sqrt{\frac{1}{16}bb} - \frac{1}{6}p$ major quam $\frac{1}{3}pb - \frac{1}{128}bbb - \frac{1}{2}q$. Quo in casu semper duæ, aliquando tres ex Radicibus sunt majores quam $\frac{1}{4}b$.

Notandum vero hic limitem illum ex minima y productum, aliquando negativum fieri, sive minorem nihilo; quoties scil. maxima ex tribus perpendicularibus major est quam GD. (Fig. II.) Hoc si acciderit quantitas + r a limite præscripto ex media y, in nihilum minui potest. Defectus vero limitis ex minima y monstrat quanta possit esse — r in æquatione, si habeantur tres radices Affirmativæ ac una Negativa; quam si excedat, non nisi duæ, altera Affirmativa, altera Negativa, dari possunt. Hæc autem omnia demonstrantur ex eo quod prædicti limites quantitatis r, sint differentiæ Quadratorem lineæ GD & perpendicularium in Curvam Parabolæ.

Ob perplexas vero cautiones, quas parit in æquationibus hisce signorum diversitas, præstat semper secundum terminum tollere, ac deinde juxta præcepta jam tradita radicum numerum ac signa inquirere; præsertim si quantitates illæ y non multum distent ab invicem. Ex quatuor autem hisce radicibus Affirmativis, duæ semper sunt minores quam $\frac{1}{4}b$, duæ vero majores; nempe si DG minor sit quam AG, sive $\frac{1}{3}pb$ quam $\frac{3}{4}b^3 + q$. Tres autem minores sunt quam $\frac{1}{4}b$, quoties perpendicularis media, sive ex media y inventa, major est quam AG, sive $\frac{1}{3}bby$ major quam $3y^3 - p y y$ ex eadem media y; Quarta vero & maxima radix major est quam maxima y + $\frac{1}{4}b$; æquatour autem differentiæ ipsius b & summx cæterarum trium radicum, ideoq; minor est b. Sed jam Manum de Tabula; Fortassis illi qui naturam Parabolæ penitus perspectam habent, majori compendio hæc omnia peragere valebunt; at si quantitates hæc omnes b. p. q. & r, absq; resolutione Cubicæ æquationis rite determinari possint, non sine causa ambigitur; quæcunq; enim æquationibus planis hæc in re sunt, non veros limites, sed approximationes tantum exhibent.

An Account of some Observations lately made at Nurenburg by Mr. P. Wurtzelbaur, shewing that the Latitude of that Place has continued without sensible alteration for 200 Years last past; as likewise the Obliquity of the Ecliptick; by comparing them with what was observed by Bernard Walther in the Year 1487, being a Discourse read before the Royal Society in one of our late Meetings.

WHETHER the Poles and Axis of the Earth be really fixt in the Globe, or subject to be transferred from place to place is an old Enquiry, though now lately revived by Mr. Hook in his ingenious essays upon the great mutations and *Catastrophies* which in all appearance have hapned to the Earth's Surface. A necessary consequence of such a translation of the Poles would be the change of the Latitudes of places, which would encrease in those Regions towards which the Poles approach, and decrease in those from which they recede: and under the Meridian 90 degrees removed from that in which the Poles shift, the Latitudes continuing the same, the Meridian Line would only alter; but no two places considerably differing in Latitude can be supposed, wherein if there be any sensible motion of the Poles, it shall not be perceived by the alteration of the Latitude of one or both of them.

The accurate Mr. *Wurtzelbaur*, has lately furnished us with the means of examining this Hypothesis by observation, having sent us the Meridian Altitudes of the Sun taken at *Nurenburg* about the two Solstices in the Year 1686. *June* the 10th. he found the Meridian Altitude of \odot 64gr. 2m. 20s. and the next Day 64gr. 2m. 25s. and on *December* 14^o. 3 days after the Solstice, wherein the Sun was got two minutes higher, he found the Meridian Altitude 17gr. 9m. 1cs.

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wherefore the solstitial Altitude was 17gr. 7m. 10s. These heights were taken by an Instrument of 6 foot Radius of Brass; and the skill and diligence of the observer is not to be doubted.

To compare with these I find among *Bernard Walthers* observations made in the same City of *Nurenburg*, two hundred Years before, viz. in the Year 1487, that the Meridian Altitude of the Sun in the summer Solstice was observed by the Parallaxick instrument of *Ptolomy*, whereby the Chord of the Suns distance from the Zenith was observed 44890 parts of 100000 Radius; the same being confirmed by the concurrence of the observations of several Years both before and after. The arch answering to this Chord gives the Suns distance from the Zenith 25gr. 56m. 30s. and consequently the Meridian Altitude its Complement to a Quadrant, 64gr. 3m. 30s. Again, the same Year 1487, the Chord of the Meridian distance of \odot from the Zenith, on the day of the Winter solstice was found 118790, confirmed likewise by many subsequent observations; the arch answering to this Chord is 72gr. 52m. 40s. and its complement 17gr. 7m. 20s. the Meridian hight of the Sun in the Winter solstice.

Hence it appears that the solstitial hights were very nearly the same at *Nurenburg* 200 Years ago as now they are, that of the Summer solstice being but one minute differing, the other only 10s. both which may possibly arise from the defects of the Instruments of these observers, being made with plaine sights; but what I shall necessarily conclude from hence is, that if there be such a motion of the Poles, it is either very slow, or else nearly at right angles to the Meridian of *Nurenburg*; in which latter case the Latitudes of places about *Tunking*, *Siam*, *Malacca* and *Java* on the one side, and in our *American* plantations of *New-England*, *Virginia*, *Jamaica* &c. on the other, ought to change fastest; but I have never yet heard of any such thing by any of our Navigators; whence if there be such a change of the Earths Poles, it must necessarily require a long time to become sensible.

Besides

Besides, from these Observations it appears that the obliquity of the Ecliptick has continued unaltered for these 200 Years last past, that is to say, that the Angle which the Earths Axis makes with the plane of the Ecliptick or Orb wherein she moves annually round the Sun, has been without sensible Change in all that time; which will be very hard to conceive, if we allow a translation of the Earths Poles; for the direction of the Axis being perfectly at Liberty, it must be purely casual, if it so hit, that after such change, it make the same Angle with the Ecliptick as before.

A farther argument of this slowness of the change of the Poles is the Latitude of *Alexandria*, the habitation of those Famous *Astronomers* of antiquity *Eratosthenes*, *Timocharis*, *Hipparchus* and *Ptolomy*, and for that reason it may be concluded that this of all the Latitudes the ancients has left us, ought to be one of the most correct. This by *Ptolomy* is said to be 30^{gr.} 58^{m.} North, (which he uses in all his computations in his *Almegist*, and seems derived from the proportion of the *Gnomon* to its Equinoctial shadow, as 5 to 3) but in his *Geography*, 31^{gr.} just. In the Year 1638 the curious and Ingenious Mr. *Greaves*, when he went to visit the *Ægyptian Pyramides*, of which he has given so good an account, did with a sufficient Instrument observe the Latitude of *Alexandria*, and found it 31^{gr.} 4^{m.} or 6 minutes more than it is reputed by *Ptolomy*, and before him by *Eratosthenes*; so that in about 2000 Years the Latitude of *Alexandria* has altered only a few minutes, and so few that the accuracy of the observations of the ancients may well be questioned: But both being granted, this motion will amount to no more than a degree in 20000 Years.

This is said not with intent to invalidate what Mr. *Hook* hath from so good grounds advanced, *viz.* that the Ball of the Earth, at least the fluids thereof, being necessarily of the Figure of a *Sphæroides prolatus*, or flat Oval, whose shortest diameter is the Axis, and greatest Circle the Equinoctial; if the Poles be supposed changed, the Equinoctial will be so

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too; and consequently the Water must rise and cover those parts from which the Poles recede, and fall off and leave bare those places towards which the Poles approach. By this means it may be accounted for, how such strange marine things are found on the tops of hills, and so deep underground; and scarce any other way. But from these and the like observations it will follow, that if these inundations are produced by any regular motion of the Poles, it would require a prodigious number of Ages to effect those changes we may be certain have been. Besides, if the access and recess of the Sea were after such a gradual manner, as when produced by such an easie translation of the Poles, as can by observation be admitted, those Inundations could never be fatal to the Inhabitants, for that they would always give notice of their Coming, so that the People might provide for their safety. But the *Holy Scriptures* and Pagan Tradition do unanimously agree, that the last great Deluge was brought to pass in a few days, with no previous notice, so that the account we have thereof, could not by this Hypothesis be made out, without the supposition of a great and sudden alteration in the Poles of the Earths diurnal Revolution; for which whether we should have recourse to the Intelligent powers that first impress this whirling motion on the Ball, or leave it to be performed naturally, by the casual Choc of some transient body, such as a Comet or the like, whereby the former Axis might be lost and a new Revolution produced, differing both in time and position from the old; I shall not undertake to dispute: such a supposition would include likewise a change of the length of the Year and Eccentricity of the Earths Orb; for which yet we have no sort of Authority.

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Fig. I.



S. CANTIAN

Fig. II.



The plan of the Grotto Podpetschio

Fig. III.



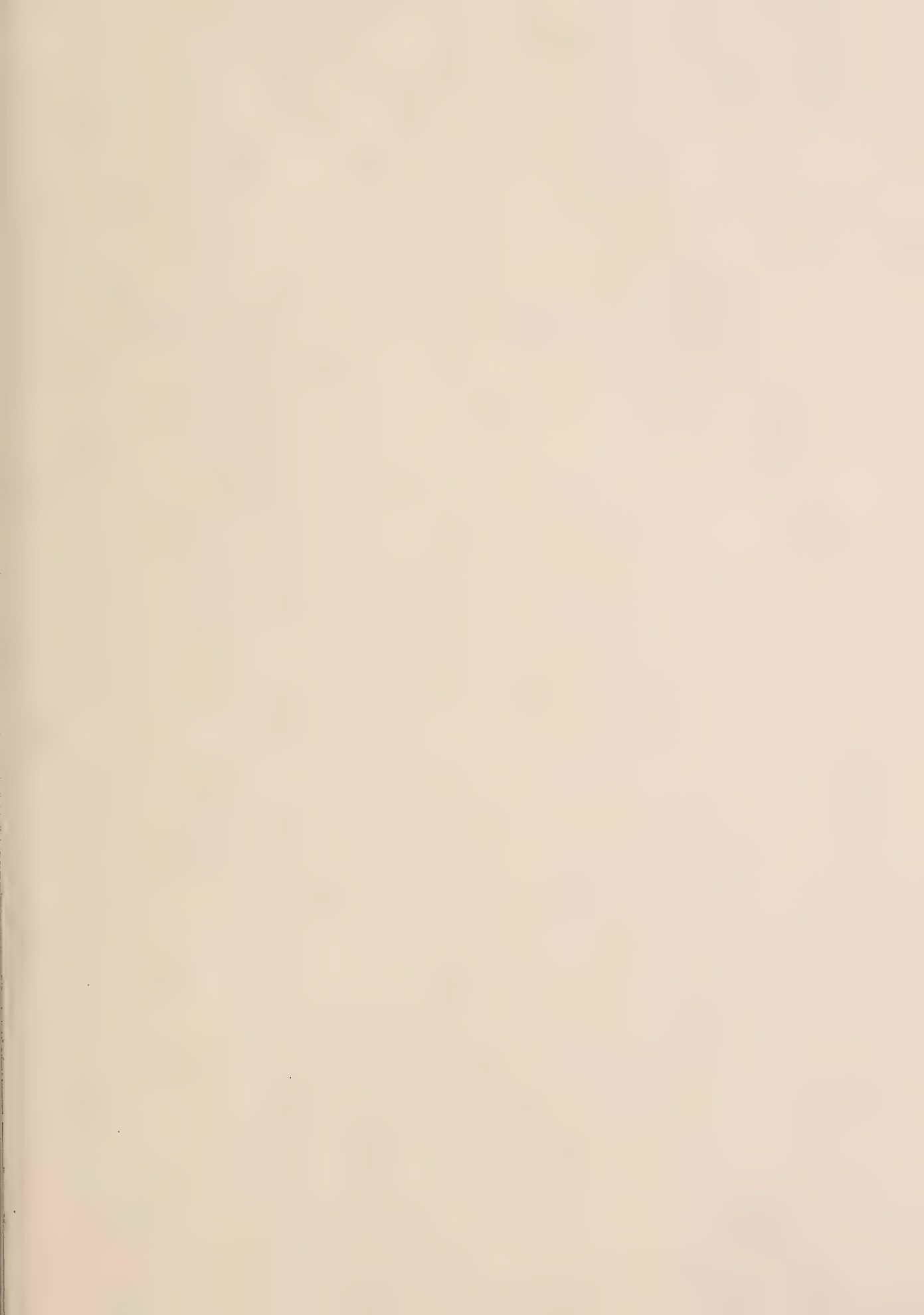


Fig. I.



the Grotto
Chio

Fig. III.



PHILOSOPHICAL TRANSACTIONS

For the Month of December, 1687.

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An

An Account of the diseases of Doggs, and several Receipts for the Cure of their Madness, and of those bitten by them. Extracted from the Papers of Dr. Theodore Mayern, and Communicated to the Royal Society by Sir Theodore de Vaux Knt. and R. Soc. S.

Doggs are Subject to these several sorts of Madness or rather diseases. (1) The *Hot Madness* which is incurable without hope. They fly upon every thing and can hold out but 4 days (2) the *Running Madness* which is likewise incurable. They fly only upon *Doggs*, and that by Fitts, and may sometimes hold out 9 months (3) *La Rage Mue* which is a disease that lies in the Blood (4) The *Falling Madness* which seases on the Head, and is as a sort of *Epilepsie* (5) The *Blasting* or *Withering*; this lies in the Bowells which shrink up exceedingly (6) The *Sleepie Disease*, which comes from little worms in the mouth of the Stomach: These *Dogs* die sleeping. (7) The *Rheumatick Disease*, This swells the Head very much and makes the Eye yellow.

These five latter are not properly Madness but other diseases. In them the *Dogs* will not eat, nor at any time when they are sick, but in these five they live 8 or 9 days without hurting any body, and then die of Hunger. The two first are catched by the breath of *Dogs* being together as is the Plague among Men, the latter are likewise Contagious but Curable.

A Never failing Remedy for the Bite of a Mad Dog.
by Sr. Theodore Mayern.

Take *Virginia Snake-Root* and Flowers of *St. Johns wort* gathered in their prime, equal parts of each, lett them be made into very fine Pouder. The Dose is from a Scruple to a Dram, to be taken in any sort of Decoction prepared with Specificks. To a Horse give 2 Dr. to a Dog from one to 1½ Dr. This before the ninth day after the Bite.

Another Receipt for the same, taken from
D. Mathias Hulsboos.

Take Leaves of *Rue* pickt from the stalks and bruised 6 Oun *London Treacle* (or which is better *Venice Treacle*) *Garlick* Pild and bruised, and fine filings of *Tin*, each 4 Oun. put them into 4l. of *Cana y* or good *White Wine*, or in case of a nice or hot constitution, into the same quantity of strong and well-workt Ale, in an Earthen vessel well stopt. Then let there be made a digestion or gentle boyl-ing therof *in Balneo*, for 4 hours, shutting in the steam, then press it and strain it.

The dose is from two to three Ounces (and in some Persons more) to be taken every Morning for 9 days. The Party bitten must fast for three hours after it, and the dreggs that remain after expression must be bound upon the wound received, renewing it every 24 hours. *N. B.* That the ninth day after the bite must not be let slip, before this medicine be taken, least the Poyson sease the Blood too Strongly. It must be given cold, or at least only a little aired. A Double Quantity may be given to a Beast soon after the Bite.

This Remedy I have given many times by Sr. *Theodore Mayerns* direction, and I never found it to faile.

Theodore De Vaux.

Another

Another approved Remedy.

Pluck the feathers from the breech of an Old *Cock*, and apply it bare to the Bite, and do this upon each of the Wounds. If the *Dog* were Mad, the *Cock* will swell and die, and the Person Bitten will do well; but if the *Cock* dies not, the *Dog* was not Mad. If the Wounds be very small, it is requisite to open them with a Lancett.

Another Process of Sr. Theodore Mayerns.

Let the Party be Nine times Plunged in the Sea, while he is fasting, as soon as may be after the Bite.

Let the Bitten Part be washed with a *Lie* of the *Ashes* of *Oke-Wood* and *Urine*, and apply a Cataplasme of *London Treacle*, *Alliaria* or *Hedge Garlicke*, *Rue* and *Salt*.

Take dried *Rue* and *Scordium* each 2 Dr. *Virginia Snake-Root* 1½ Dr. Flowers of *St. Johns wort* 3 Dr. fine filings of *Tinn* and *Garlik* cut small, each 4 Dr. *London Treacle* 1 Ounce. Let them be all beaten and exactly mixed together, adding *Syrup* of *Lemon Pils* as much as suffices to make it into an *Electuary*; Divide this into Nine equal parts to be taken every day one, drinking after it a small draught of Good strong Ale. Let him walk upon it and not dine till 4 hours after.

Use as little of the aforesaid *Syrup* of *Lemon Pils* as may be: and if that be not at hand, a *Syrup* made of *Malagawine*, adding as much *Sugar* as it can dissolve, may serve the turn.

Make up of this *Electuary* 4 ½ Ounces at a time, that so the Dose may be half an Ounce.

An Extract of a Letter written to the Royal Society out of Carniola, by Mr. John Weichard Valvasor R. Soc. S. being a full and accurate description of the wonderfull Lake of Zirknitz in that Country. Vide Phil Transact. N. 54, & 109.

THis Lake was by the Ancients called *Lugea Palus*, by the moderns *Lacus Lugeus*, tho at present its Latine name be *Lacus Cirknicensis*, in high Dutch *Zircknizer-see*, and in our Carniolan tongue *Zirknisko Jesero*. Why it was so called of old is unknown or very uncertain; but the original of the present name is more sure, it being derived from the adjacent town of *Cirknitz*: and that had its name, from a Chappel of the *Virgin Mary*, which at first stood alone, but now the town is built round it. This Chappel was no great edifice at first, and therefore was called the little Chappel, which in the Language of the Countrey is *Zirkuiza*; whence the Lake was named *Zirkuiska Jesero* or the Chappel-Lake, but now by abuse being changed into *Zirknisko Jesero*.

It is distant from the Capitall City of the Province *Labac*, six German miles; it is a good German Mile long, or better than 4000 Geometrical paces; and is about half as much in breadth. Its ordinary depth is 10 Cubits, its least 5 or 6, rarely three, but its greatest is sixteen Cubits. It is every where surrounded with woody mountains, which on the South and West side are very high and three Miles broad, running far in length into the *Turkish* country, and afford nothing but horrid stony deserts, overgrown with trees. On the North and East

side there is, between the Mountains and the Lake, a small territory, which tho narrow is nevertheless pleasant, and is inhabited by one Town, three Castles and nine Villages, adorned with twenty Churches: as may be seen in the Map I send (*Fig. I*) which was drawn by my self upon the place, with all possible care.

In the Mountain called *Iavornik* standing near the Lake, there are two holes, or exceeding deep precipices, in which many thousand wild Pidgeons roost all the Winter; entring in Autumn, and coming out with the first of the Spring: What they live upon in these caverns is unknown, but I take it to be the Nitrous Sand. In the other hill called *Slivenza*, tis the belief of the Country People that the Witches hold there assemblys, because that several times lights like *Jignes fatui* are observed there. On the top of this hill is a hole of an unknown depth, out of which there often breath out noxious steams, supposed to occasion tempests of Thunder and Lightning and Hail; and for this reason the Priest of *Zircknits* every *Whitson-Munday* goes to the Hole in Procession, and uses over it a certain form of Exorcisme.

There runn into this Lake continually eight Rivulets. The two least are called *Bellebrech* and *Tresenz*; the third is the fountain *Oberch*, out of which abundance of Water gushes with great force; the fourth fifth and sixth called *Steberziza*, *Lipsinziza* and *Seromschiza*, may for their bigness deserve the name of Rivers; the seventh called *Martinschiza* breaks out at a cleft in the Rock: The Last called *Cirknizer-ach* is a pretty larg River.

Now this Lake being every where surrounded with Mountains, and nowhere running over, Nature has given it two visible Channels or stony Caverns, called *Velka-Karlouza* and *Mala-Karlouza*, by which the Water runs under the Mountain; and a third concealed subterraneous Passage, which without doubt communicates with the other two under ground (as I shall hereafter prove) These
having

having run half a German Mile, come out at the other side of the Mountain, near the Chappel of *St. Cantian* (as I have faithfully drawn it in *Fig. II.*) in a desert place at a stony Cave *A*; and become the River called by the inhabitants *Jesero*, that is *the Lake*. This River *Jesero* marked *B*, is reasonably bigg, and having run half a quarter of a Mile, enters a wide stony Cavern, *I*, running slowly under the hill for the space of a good Musquet-shott; then coming out again on the other side, after it has run thro a small platt *m, m*; it enters a third Cavern or Grotto *C*; wherein having passed 50 Paces, one may say *Siste Viator, ne plus ultra*, for it runs no longer peacibly as before, but with great noise and roaring falls down a very much inclined channel of stone, so that neither I nor any else durst follow it farther. In *June 1678* I went myself in a small fisher-boat under the Mountain, through the Cave *I*, and entred the Grotto *C*, till I came to the afore-said *Falls*, without any danger or trouble, the passage being wide enough.

It must be noted, that the Valley wherein this River *Jesero* runs, is exceeding steep, but the Plat of Ground *m, m*, is plain and stony, of an Oval Form, and is surrounded with (as it were) a very high Rampart *K, K, K*, so steep, that it would be impossible for a Cat to climb out of it, unless at one place, whereat a Man may make a shift to go up and down, tho' not without peril of his Life; the Way being in some places not above three or four Inches, and no where above six Inches wide. In the Year 1684 I went down here in Company with a *French Gentleman*, but the Water being up and we wanting a Boat, we could not go under the Hill nor enter the Grotto *C*; so we returned, and with great difficulty descended by a steep and narrow Passage at *D*, and came to a Cave bigger than any Church, through which the River *Jesero* runs. Here we found several Figures of Stone, the Workmanhip of Nature, and strange Holes or Caverns in the

Earth ; but by reason the River was then up, we could go no farther. At other times when the Water is down, one may go with lighted Torches a great way underground ; and 'tis said there are here very odd Figures formed by the petrified Water : among the rest, one resembling a Weaver at Work, of which the Country People want not their Superstitious Traditions.

But to return to our Lake ; I say that about the Feast of St. *John Baptist* or St. *James-Tide*, and sometimes not till *August*, the Water runs away and it is dry : But it fills again most commonly in *October* or *November*, yet so as not to observe any certain time ; for sometimes it has been drie twice or thrice in a Year : as in the Year 168., it was dry in *January*. Again the Water began to draw off, on the 15th of *August* St. *N.* and it was quite clear by the 8th of *Sept.* and this present Year 1687, it has been thrice empty, which makes the Fishing very poor and inconsiderable. Sometimes again, tho' but seldom, it has hapned to be three or four Years together full of Water, and then is the best of the Fishing. But it never yet was observed that this Lake was dry for a whole Year together.

The right of Fishing in this Lake, upon certain Terms agreed on, does at this time belong to the Lordships or Castles following, 1. to *Haasberg*, 2. *Steegberg*, 3. *Laas*, 4. *Schneeberg*, 5. *Avesberg*, 6. to *Sitticium*, which is a Monastery of *Cistercian Monks*.

There are three Ilands in this Lake, viz. *Mala-Goriza* and *Velka-Goriza* which are uninhabited. The third is a very pretty Iland called *Vornek* that is reasonably big, having upon it a Village of four Houses called *Ottok*; above this Town upon a little eminence stands a Church, which is no small Ornament. Those that live on it have Fields, Meddows, Pastures, Wood, Gardens and Orchards, and all things necessary for Life.

There is also a very fine *Peninsula* all covered with Wood, called *Dorvassek*. When the Lake is up, and one comes

comes in a Boat between the Iland *Vornek* and this *Peninsula*, the farther part of the Lake, lying under the Mountain, very well resembles a curious Port for Shipping. At the farther end when the Water draws off, there appears rows of Stakes, a Signe that there hath been formerly a Bridge, and therefore it is at this day called the *Old Bridge*.

In this Lake there are many Pitts in the shape of Basons or Cauldrons, which are not all of the same depth or breadth, the breadth of them being from 20 to 60 Cubits more or less, and the depth from 8 to 20 Cubits. In the bottom of these Pitts are several holes, at which the Water and Fishes enter, when the Lake ebbs away.

The principal Pitts in which they Fish are Eighteen, situated and named as is represented in the first Fig. They are called *Maijoberch*, *Velkjoberch*, *Kamine*, *Sueinskajamma*, *Vodonos*, *Louretschka*, *Kyaloudnor*, *Resceto*, *Ribeskajamma*, *Rethje*, *Sittarza*, *Lipauza*, *Gebno*, *Koten*, *Ainz*, *Zeslenza*, *Pounigk*, and *Levishe*. Besides these there are several other lesser Pitts of no Note, because there is no such Fishing in them as in those but now mentioned.

In the Months of *June*, *July*, and *August*, when this Lake begins to draw off, it grows quite drie in 25 Days, if no great Rains intervene. And the aforesaid 18 Pitts, are all emptied one after the other, in a certain and never failing Order of Time.

When the Lake begins to sink, which appears by a certain Stone which they observe, the Inhabitants of the Town called *Oberdorff* or *Seedorf*, give Notice thereof to all the Neighbouring Fishermen, that are appointed by the several Lords having Right in this Fishing. The People of this Town have Orders not only to watch the falling away of the Water, but likewise to take care that no body presume to Fish in the Lake when it is full of Water; that being forbidden: so that these are as it were the Keepers of the Lake.

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The first Pitt called *Maljoberch*, is not properly a Pitt like a Cauldron, but only a depression of the bottom without any holes in it : but there grows much Grass and Weeds, and may Fish are Caught therein : Three days after the Water begins to Ebb, this Pitt is emptied : Then the Parish Clark of *Seedorff* gives Notice thereof by Tolling a Bell, and all the Inhabitants of the Town, Old and Young, Men and Women, lay aside all other Business and go to Fishing, stark naked as they were born, without any regard to Modesty or Shame. The Fish they Catch, they divide in halves, one part they give to the Prince of *Eggenberg*, as the Lord of the Mannour, the other half is their own.

(2.) The Pitt *Velkioberch* is emptied the third day after *Maljoberch*, the manner and right of Fishing as in that.

(3.) Four Hours after this, the Pitt *Kamine* begins to empty ; here they generally Fish with a Trawle, as in several other Pitts of lesser Note, having first purchased leave of the aforesaid Lord of the Mannour. Here, as likewise in the Pitt (4.) *Sueinskajamma*. (which sinks one hour after *Kamine*) is much Fish caught, and an abundance of large *Crabbs*, but they are lean and of no good tast.

(5.) The fifth Pitt *Vodonos*, dries five days after *Kamine*. In this and the other Pitts which follow, they Fish with a long Nett or Sayne. Herein they can have no more than five or six *Hawl's*, by reason of the great swiftness wherewith the Water runs away at the holes in the Bottom, (which is such that a Horse can hardly keep pace with it) and carries away the Fish with great violence under the Earth. Sometimes when the Fishermen are not nimble, they can scarce get two *Hawl's* before the Water be gon ; to prevent which they have a Mark near this Pitt, viz. the Stone *Ribes ekanen*, that is *The Fishers Stone*, which as soon as it begins to appear upon the recess

cess of the Water, gives Notice that it is time to begin the Fishing.

(6.) The Pitt *Louretschka* is evacuated a day and a half after *Vodonos*, the Fishing is after the same manner, and the same Caution necessary, because of the suddain recess of the Water.

(7.) The Water leaves the Pit *Kyaloudnuor* twelve hours after *Louretschka*; and three days after that (8.) the Pitt *Rescheto*. In this latter, in the Year 1685, after the Lake had been some Years without being dry, there were taken at the first Hawl, 21 Carts of Fish, at the second 17, and at the third 9, as I have been credibly informed by those that were present.

(9.) The Pitt *Ribeskajamma* falls dry at the same time with *Rescheto*, which is that next to it. In this Pitt they fish under ground, which is a Curiosity not unpleasant, and differing from all the rest. For there is in the Bottom a great hole in the Stone, by which Men may easily go down with lighted Torches, as into a deep Cistern; and there is under ground a large Cavern like a Vault, the Bottom or Pavement whereof is as it were a Sive full of little Holes, whereby the Water runs away leaving the Fish dry, where they are Caught.

(10.) The Pitt *Rethje* is empty two hours after *Ribeskajamma*, and is of no great Consequence for Fish: An hour after this the Pitt (11.) *Sittarza*, and in five or six hours more (12.) *Lipauza* falls dry.

(13.) The third Day after *Rescheto* the Pitt *Gebno* is evacuated; in this they rarely Fish with Netts, but let it fall dry, and the Holes in the Bottom being so small, that they exceed not the size of a Mans Arm, all the great Fish are left behind in the Pitt.

(14.) Two days after *Gebno* the Pitt *Koten* becomes dry: In this they sometimes take the Fish as in the former, but the Holes being greater let bigger Fishes pass.

(15.) The Pitt *Ainz* empties 4 or 5 hours after *Koten*: In this

this they seldom (unless they cannot help it) let the Water run away without using their Netts, as in *Gebro*; because of one great Hole in the Bottom, whereby many great Fishes may escape. (16.) The Pitt *Zeslenza* sinks three hours after *Ainz*; in this they allways Fish with Netts, as in (17.) *Pounigk*, which is emptied the next day after *Koten*.

(18.) The last Pitt called *Leuifche* is evacuated the third Day after *Pounigk*, that is the 25th. Day from the beginning of the Recess of the Water of the Lake, so that in 25 Days the Fishing of this Lake is over. In this last Pitt, about 17 Years since, I am certainly informed, that there fell a Flash of Lightning, about the Time of Fishing; which stunned a great Multitude of large Fishes, so as they fill'd 28 Carts with them: (By a Cart is meant as much as one Horse can draw) These Fish are not properly Thunder-struck, but only stunned with the Violence and Sulfurous Vapour of the Lightning, which makes them rise and swim as dead upon the top of the Water; but if they be taken up and put in fresh Water, they soon recover, otherwise they Die: This is no uncommon Accident in this Lake.

The Fishing being thus ended, a Signe is given by tolling the Bell in the Chappel of St. *John Baptist*, near the Town of *Cirkniz*. Upon which all the Inhabitants of the neighbouring Villages and of *Cirkniz*, without regard either to Age or Sex, go, for the most part stark naked, into the Lake, and look for Fish among the Weeds and Sedge, and in the smaller Pitts. And many creep into the Subterraneous Caverns and Passages, and find store of large Fishes there. They having full Liberty to search all over the Lake, excepting in the Pitts *Pianze*, *Narte*, and *Velkjoberch*. This Barbarous and Immodest Custom of going Naked, has been often attempted to be reclaimed by the *Carthusian Monks*, but all in vain, for so prevalent is a Habit of vicious Practices over good Precepts, that they

they have not yet been able to perswade them so much as to cover their Secrets.

There are besides these some other Pitts in the Lake, as *Skednenza*, *Mala* and *Velka-bobnarza*, in which they Fish likewise, as also in *Mala-karlouza* and *Velka-karlouza*: In both these they go far under ground with lighted Torchés and find Fish, but these Pitts are of no great value. In *Velka-bobnarza* one may go in at great holes, and descend many Fathoms under ground. These two Names *Velka* and *Mala-bobnarza*, signify in the *Carniolan* Tongue the *Greater* and *Lesser Drummer*; nor is it without Reason that these Pitts are so called; for when it Thunders and Lightens, there is heard in these two Pitts, as it were, the Sound of many Drums Beating, which *Anno 1685*, I heard with my own Ears; it Thundring three times successively, and the Sound of Drums answering accordingly.

The two Pitts *Narte* and *Pianze*, are never emptied, but always remain Fenny, when the rest of the Lake is quite dry. It is believed, that in these Pitts the Fish lay their Spawn, and therefore it is prohibited to Fish in them. In them is an incredible Number of *Horse-leeches*, which according to the vulgar Opinion, understand certain Words; for that upon repeating them, they will come in great Parties towards him that repeats them, whereas if he be silent, very few of them will touch him. These *Horse-leeches* often stick upon the People in the fishing time, (some of them being dispersed all over the Lake) and the Method they take to get them off, is to get some other Person to piss upon the *Leech*, which makes it let go its hold; and this without any respect to Modesty is practised, as well upon the Women as Men.

There are in the Mountain nigh the Lake, but something higher than it, two great and terrible stony Caves, the one called *Urainajamma*, the other *Sekadulze*, which tho' far distant one from the other have yet the same Effect, viz. when it Thunders and Lightens, these two

Caves do emit Water with a wonderful and incredible force, and with it sometimes a great quantity of *Ducks* with some Fish; which I my self observed in *October* 1685, not without great danger of my Life. I took my Horse and rid Cross the Lake, as far as the Iland *Vornek*, in Company with two old experienced Fishermen; when suddainly the Cavern in the Mountain *Slivenza*, began to breath forth misty Vapours forming a Cloud. Upon which my Fishermen advised me to make hast, for without doubt those Clouds would produce a Tempest. They had scarce said so, when it began to Lighten and Thunder dreadfully; and I had difficulty to perswade them to accompany me as far as the Pitt *Velkabobnarza*, being desirous to examine what is said of it, that when it Thunders the Sound of many Drummers is heard in it. This I found three times to succeed as reported; and then with all the speed we could, we hasted to the Iland *Velka-Goriza*, not being able to go farther, because the Water was in many places grown out of our depth, where two hours before we had passed drie. Here we got one of the little Fisher-boats, which when the Lake is drie lie disperfed here and there on the bottom; and having got in my Horse, we began our Voyage, but had the ill luck to overset our Boat, and so were obliged to Swim for't, and with much to do arrived safe on the other Shore. Then we could see from the other side that the Water gushed with great *Impetus* out of the Cave *Sekadulze*, being cast three or four Fathoms, as if it were forced by a *Fire-Engine*, and several blind *Ducks* were thrown out by the Water. It is not to be wondred that the Lake fills so fast, for considering the Violence wherewith the Water rushes, it is as much as a great River; this Cave *Sekadulze*, being a Fathom wide, and higher than a Man. It is lookt upon as a dangerous thing to enter into this Cave, because the Water come so all on a suddain, that if it should chance to come, it is impossible to escape it.

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When it Rains moderately, the Water spouts with great Violence two or three Fathoms perpendicularly, out of the Pitts *Koten* and *Zeslenza*. It comes likewise forceable out of the Spring *Tresenz*, as likewise out of *Velkioberch*, bringing with it at this latter abundance of Fish, and some *Ducks*. But when it Rains very hard and long together, especially with Thunder, then the Water breaks out with very great force, not only from all the aforesaid Pitts, Holes and Caves, but likewise at several thousand other little holes (which are all over the bottom of the Lake, and which when the Lake is dry, drink up the Waters of the eight Rivulets that run into it) spirting several Fathoms high, from some perpendicularly, from others obliquely, so that there is not a pleasanter sight than this. And out of the Pitts, *Vodonos*, *Rescheto*, and some others having great holes at the Bottom, there comes with the Water a great quantity of Fish. In case of great Rains, the eight Rivulets are likewise much encreased, so that all things concurring, this Lake in 24 hours time, will from quite dry be full of Water, and sometimes in 18 hours; tho' at other times it has been known to be three Weeks in filling: But it is a constant Observation, that Thunder and Lightning help much to fill it speedily.

This Lake being thus by turns wet and dry, serves the Inhabitants for many purposes. For, first, while it is full of Water, it draws to it several sorts of *Wild-Geese* and *Ducks*, and other Water-Fowl, as *Hérons*, *Swans*, and the like, which may be shot, and are very good Meat.

Next as soon as the Lake is emptied, they pluck up the Rushes and Weeds, which make excellent Litter for Cattle. 3. Twenty days after it is fully dry, they do cut a great quantity of Hay upon it. 4. After the Hay is inn, they Plow it and sow *Millet*, which sometimes by the too suddain coming of the Water is destroyed, but it generally comes to Maturity. 5. While the *Millet* is on the
K k k 2 Ground

Ground they catch a great Number of Quails. 6. The *Millet* being inn, there is good Pasture for Cattle. 7. When the Lake is dry, there is great variety of Hunting ; there coming out of neighbouring Woods and Mountains plenty of Hares, Foxes, Deer, Swine, Bears, &c. so soon as the Water is gone. 8. When it is full, one may Fish in it. 9. In Winter time it will be so firmly frozen as to bear all sorts of Carriages, and is a great convenience to the People to fetch their Wood and other Necessaries ; lastly at the time when the Water goes away, it yields great abundance of Fish, as has been already said. And that which is most Wonderful is, that all this comes to pass in the same place, and the same Year, *viz.* If the Lake be early dry, and it fill not too soon ; but it is to be noted, that the Hay does not grow, nor is the *Millet* sown all over the Lake, but only in the more fertile places.

There are only three sorts of Fish taken in this Lake, which are very well tasted. They are the *Mustela Fluviatilis* or *Eel-pout*, some of them weighing 2 or 3 Pounds. *Tench*, some of them weighing 6 or 7 Pounds ; and thirdly *Pikes* in very great plenty, of 10, 20, 30, and some of 40 Pound weight ; in the Bellies of these it is common to find whole Ducks. Crabbs are found no where but in the Pitts *Kamine* and *Sueinskajamma* ; they are large but ill tasted.

The Cause or rather *Modus* of all these wonderful *Phænomena* in the Lake of *Zirknitz* is, according to my Opinion and Speculations, as followeth. There is under the Bottom of the Lake, another Subterraneous One, with which it communicates by the several holes described : There are also one or more Lakes under the Mountain *Javornik*, but whose surface is higher than that of the Lake of *Zirknitz*. This upper Lake is possibly fed by some of those many Rivers, which in this Country bury themselves under ground, and has a Passage sufficient to carry the Waters they ordinarily bring unto it ; but when it
Rains,

Rains, especially in Thunder Showers, which are the most hasty, the Water is precipitated with great Violence down the steep Valleys, in which are the Channels of these Rivulets; so that the Water in this Lake, being encreased by the suddain coming in of the Rains faster than it can empty, swells presently: and finding several Holes or Caverns in the Mountain higher than its ordinary surface, it runs over by them both into the Subterraneous Lake under that of *Cirknitz*, (into which the Water comes up by the several Holes or Pitts in the Bottom thereof) as likewise by visible Passages above ground, such as *Urainajamma*, *Sekadulze*, and *Tresenz*.

That some of these Passages, bring *Fish*, some *Ducks* and *Fish*, others only Water, seems to depend on the position of the inward Mouths of these Subterraneous Channels; for if they be so constituted, as to draw off the Water from the surface of the upper Lake, on which the *Ducks* swim, they must needs be drawn away by the Stream into these Caverns, and come out with the Water: But if so be that the Channels open, into the upper Lake, under the surface of the Water, and from thence ascend obliquely for some space, before they come to descend; then the Water they carry is drawn from below the surface, and consequently can bring with it no *Ducks*, but only *Fish*. Those Pitts which yield only Water, may well be supposed to be fed by passages too narrow to let the *Fish* pass, tho' their multitude may make the quantity of Water they emit to be very considerable.

The Manner of the falling away of the Water or emptying of the Lake, I thus explain. After a long drought or want of Rain, all the Springs that feed the upper Lake under *Javornik* are much diminished; so that wanting fresh supplies, it ceases to run over by the several Channels, but now mentioned: hence the Lake of *Zirknitz*, and that under it, are fed only by the eight Rivulets that always fall into them; and then the Water draws off faster

than it comes in, both by the Channells of *Mala* and *Velka-Karlouza*, as also by a concealed Subterraneous Passage out of the under Lake, which latter alone is able to transmit more Water, than the said eight Rivulets afford. Consequently the Lake must sink, and that in a certain proportion of Time, depending on the quantity of Water to be evacuated, compared with the excess of that that runs out above that that enters it, in the same time : Those Pitts that are higher are soonest drie, the lower latest, and so come to be emptied in the Order above described. And when the Lake is all dry, then the said Rivulets soak by several little holes in the Bottom, into the under Lake, and all their Water is carried away by the aforesaid Subterraneous Passage.

That there is such a Passage is very evident, and that it communicates under ground with the Channells of *Mala* and *Velka-Karlouza*, coming out with them, as has been already said, near *St. Cantian* at a Rocky Cave, and making the River *Jesero*. For when the Lake of *Zirknitz* is very full, and runs out at both *Velka* and *Mala-Karlouza*, the River *Jesero* at *St. Cantian* overflows, and runs with great Violence. When it only runs out at *Mala-Karlouza* (which is somewhat lower than the other) then the Water of *Jesero* is much less rapid. But when the Lake is so fallen, that it runs out at neither of the two, the River *Jesero* is still less, but runs with a considerable Stream, till two days after the Lake has been dry ; after which, the said River becomes little, voiding no more Water than the Lake receives from the eight Rivulets that run into it ; by which it is clearly proved, that this Subterraneous Passage does meet with the Channells of *Velka* and *Mala-Karlouza*, and needs no farther Illustration.

Hence it appears, why this Lake sometimes is twice or thrice drie in a Year, at other times continues full for 3 or 4 Years together, but was never known to be drie for a whole Years time ; for it falls drie at any time when
there

there falls but little Rain in a long space of time ; and in Rainy Years it continues always full ; but it never happens in this Country, that there is a drought for a whole Year together.

The *Ducks* I have so often mentioned, and which are cast out with the Water, are generated in the Lake, under the Mountain *Javornic* ; when they first come out, they swim well, but are stark blind, and have no Feathers on them, or but few, and therefore are easily caught ; but in 14 days time they get Feathers, and recover their sight yet sooner, and afterwards fly away in Flocks. They are black, only white on the Fore-head, their Bodies not bigg, resembling ordinary *Wild-Ducks*, and are of a good tast, but too fatt, having near as much fatt as lean.

I kill'd some of them as soon as they had been cast out at *Sekadulze*, and opening their Bodies, I found in them much sand, and in some few, small Fishes ; in others green stufflike Grass or Herbs : which was the more strange, because I never found any green thing growing in any of our Subterraneous Grottoes or Lakes in *Carniola* ; I tried also to procure some of the Fish at the time of their being cast out, to open them and see what they live upon, but notwithstanding all my endeavour, I could not get any of them to satisfy my Curiosity withall.

Almost every Year, at a Hole in the Mountain called *Storseg*, about half a *German* Mile from the Lake of *Zirknitz*, near the Town of *Laas*, whenever there happen great Floods of Rain, this sort of *Ducks* is cast out in great abundance, by the Water gushing out with much force. I conceive that this Cavern *Storseg* is another Passage out of the same Lake under *Javornic*, that overflows and fills up our Lake of *Zirknitz* ; but this being somewhat higher, it never runs out, unless the said Lake be more than ordinary swell'd by the Violence of the Rains. The casting out of great Numbers of *Ducks* here, is so common that it is lookt upon as no Rarity.

It may

It may seem strange and hard to believe, that there should be such Subterraneous Lakes and Channels as we here suppose ; but besides that without them it would be impossible to account for all these several Effects, which are most true, and which I my self have observed ; there is a most Notable Instance of the like things, found in the Subterranean Cavern called, *The Grotto Podpetschio*, which is represented in *Fig. III.*

This *Grotto* is in *Carniola* in the Parish of *Guetenffeld*, distant four *German Miles* from the City *Labac*. *a* is a Hole or entrance into the Rocky Mountain ; *b* is a great Cavern in the Mountain, capable to hold above a hundred Horsemen ; *i, k* is a Channel bigg enough for a Man to pass by, as far as the Lake *o*, out of which Lake the Inhabitants hereabouts draw all their Water, (having none nearer) and fetch it with lighted Torches. Into this Lake *o* the Water runs with a great stream by the Channel *l*. And out of this Lake it fall down a Precipice into a great Cavern, with so much noise that the discharge of a Pistol would not be heard here. There is likewise another Channel *m* which tends upwards obliquely, and leads to the great Lake *n*, whose length and breadth are hitherto undiscovered ; I lookt about it with many lights, and could see nothing but Water, and throwing Stones several ways as far as I could, I heard them all fall in the Water : and I found the depth of it near the Bank to be 10 Cubits, and doubt not but it is much deeper in the middle.

The Country People told me, that this Channel *l* affords always an equal quantity of Water, or else is quite dry ; and that somtimes it will cease to run in a Moment, and continue dry for some Weeks, and then on a suddain it will run again with great force, so as the Noise thereof frequently frights the People as they come for Water.

Out of the Cave *b* there is another Channel *c*, which is divided into three others *d, e, f*. This Channel *f* tends obliquely

obliquely downwards, till it comes to a running Water in *g*, from whence one may go on to *h*, where looking thro' a little hole, one may see another little Lake.

All the Channels I have mentioned, are formed in a very hard Rock, and are smooth or polished, as if cut by Mens Hands : These may be seen by any one that will go with lighted Torches ; and there are many such, in which I have not been.

If any one would carry a Boat to the Lake *n*, and would row upon it, I doubt not but he might find several curious things. I believe this Subterraneous Lake to be a German Mile long : for from this Grotto *Podpetschio*, at a Miles distance, there is a Village called *Kumpale*, whose Inhabitants have no other Water, than what they fetch out of a hole in the Rock, going with lighted Torches, by a large Channel, to a great Lake under ground. I measured with good Geometrical Instruments, such as Miners use, the Level of these two Lakes of *Podpetschio* and *Kumpale*, and found them to be in one Horizon ; and this I did twice, both when the Channel *l* at *Podpetschio* run, and when it did not run. When it began to run, I found that the Lake *n* was two Cubits higher than it had been before ; when it ceased to run, I came again on purpose to observe it, and found that then also, the other Lake at *Kumpale* was in the same Level ; from whence it is most certain, that these two, are only one continued Subterranean Lake, &c.

A Correct TIDE-TABLE, shewing the true Times of
the *High-waters* at *London-Bridge* to every Day in the
Year 1688. By *J. Flamsteed* Math. Reg. & R. S. S.

JANUARY. FEBRUARY.								MARCH.								
M.				A.				M.				A.				
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	D.	
1	8	07	8	37	9	54	0	31	9	40	10	17			1	
2	9	10	9	44	11	07	11	43	0	50	11	22			2	
3	10	19	10	55			0	15	11	52					3	
4	11	30			0	45	1	12	0	20	0	46			4	
5	0	05	0	39	1	37	2	00	1	10	1	32			5	
6	1	09	1	36	2	19	2	36	1	52	2	10			6	
7	2	02	2	25	2	52	3	07	2	27	2	43			7	
8	2	04	3	03	3	22	3	36	2	58	3	12			8	
9	3	20	3	35	3	50	4	03	3	26	3	39			9	
10	3	50	4	04	4	16	4	29	3	53	4	07			10	
11	4	18	4	33	4	43	4	5	4	22	4	37			11	
12	4	47	5	01	5	14	5	33	4	55	5	15			12	
13	5	1	5	34	5	54	6	1	5	38	6	04			13	
14	5	52	6	11	6	43	7	13	6	31	7	01			14	
15	6	03	6	55	7	44	8	20	7	36	8	12			15	
16	7	19	7	45	8	57	9	37	8	5	9	29			16	
17	8	16	8	49	10	18	10	59	10	07	10	47			17	
18	9	24	10	01	11	40			11	24	11	58			18	
19	10	38	11	18	0	16	0	50			0	30			19	
20	11	57			1	20	1	49	1	00	1	2			20	
21	0	34	1	08	2	15	2	36	1	53	2	16			21	
22	1	03	2	07	2	56	3	14	2	38	2	58			22	
23	2	32	2	56	3	32	3	49	3	17	3	35			23	
24	3	15	3	33	4	06	4	23	3	54	4	12			24	
25	3	50	4	07	4	42	5	02	4	32	4	53			25	
26	4	24	4	42	5	24	5	48	5	17	5	42			26	
27	5	00	5	20	6	15	6	46	6	10	6	39			27	
28	5	41	6	05	7	18	7	52	7	09	7	42			28	
29	6	03	7	01	8	28	9	02	8	15	8	49			29	
30	7	32	8	04					9	20	9	53			30	
31	8	41	9	16					10	24	10	54			31	

A Correct TIDE-TABLE, by J. Flam-
steed, Math. Reg. & R. S. S.

	A P R I L.				M A Y.				J U N E.					
	M.		A.		M.		A.		M.		A.			
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	D.	
1	11	10	21	11	48	11	29	1	49		00	15	1	
2				0	12			0	13	00	44	1	12	2
3	0	35	0	57	0	38	1	02	1	39	2	05	3	
4	1	18	1	38	1	24	1	45	2	28	2	50	4	
5	1	57	2	15	2	06	2	27	3	11	3	30	5	
6	2	32	2	4	2	47	3	06	3	50	4	09	6	
7	3	05	3	21	3	24	3	42	4	28	4	48	7	
8	4	36	3	5	4	00	4	19	5	09	5	30	8	
9	4	10	4	28	4	40	5	01	5	53	6	16	9	
10	4	47	5	08	5	2	5	50	6	41	7	08	10	
11	5	31	5	58	6	17	6	44	7	35	8	05	11	
12	6	26	6	55	7	14	7	55	8	36	9	10	12	
13	7	30	8	08	8	17	8	49	9	43	10	18	13	
14	8	41	9	16	9	19	9	51	10	52	11	29	14	
15	9	51	10	26	10	23	10	57			00	04	15	
16	10	59	11	33	11	30			00	39	1	10	16	
17			0	05	00	03	00	23	1	40	2	07	17	
18	00	36	1	04	0	59	1	33	2	31	2	55	18	
19	1	31	1	55	2	01	2	27	3	14	3	33	19	
20	2	20	2	43	2	51	3	13	3	51	4	08	20	
21	3	04	3	24	3	33	3	51	4	24	4	40	21	
22	3	24	4	04	4	10	4	30	4	56	5	13	22	
23	4	43	4	44	4	50	5	10	5	30	5	50	23	
24	5	07	5	30	5	31	5	54	6	08	6	28	24	
25	5	56	6	23	6	15	6	38	6	50	7	11	25	
26	6	49	7	18	7	01	7	25	7	34	7	59	26	
27	7	47	8	17	7	49	8	15	8	26	8	54	27	
28	8	46	9	13	8	41	9	05	9	23	9	53	28	
29	9	40	10	07	9	31	9	56	10	25	10	58	29	
30	10	37	11	00	10	23	10	51	11	33			30	
31					11	19	11	47					31	

A Correct TIDE-TABLE, by J. Flam-
steed, Math. Reg. & R. S. S.

JULY.				AUGUST.				SEPTEMBER.			
M.		A.		M.		A.		M.		A.	
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	D.
1	6	08	0	41	1	51	2	17	3	08	1
2	1	12	1	41	2	39	3	00	3	39	2
3	2	10	2	36	3	18	3	36	4	13	3
4	2	56	3	16	3	52	4	10	4	52	4
5	3	35	3	52	4	26	4	45	5	39	5
6	4	10	4	26	5	05	5	25	6	3	6
7	4	45	5	04	5	49	6	14	7	49	7
8	5	24	5	46	6	41	7	13	9	00	8
9	6	09	6	34	7	47	8	23	10	14	9
10	7	00	7	30	9	01	9	4	11	24	10
11	8	02	8	36	10	19	10	57		00	11
12	9	01	9	50	11	31		00	46	1	12
13	10	27	11	04	0	06	0	40	1	31	13
14	1	34			1	07	1	33	2	08	14
15	00	08	0	52	1	55	2	15	2	40	15
16	1	22	1	51	2	34	2	51	3	09	16
17	2	14	2	36	3	05	3	19	3	37	17
18	2	56	3	13	3	33	3	46	4	06	18
19	3	29	3	45	3	59	4	12	4	38	19
20	3	58	4	11	4	24	4	46	5	14	20
21	4	2	4	39	4	55	5	12	6	0	21
22	4	53	5	08	5	30	5	51	6	58	22
23	5	24	5	41	6	15	6	4	8	05	23
24	6	0	6	22	7	11	7	43	9	20	24
25	6	43	7	08	8	17	8	5	10		25
26	7	35	8	05	9	31	10	10	11	44	26
27	8	3	9	13	10	49	11	26	00	16	27
28	9	50	10	27		00	03	1	13	1	28
29	11	03	11	41	0	37	1	08	2	04	29
30		00	18	1	36	2	01	2	48	3	30
31	0	52	1	2	2	24	2	4			31

A Correct TIDE-TABLE, by J. Flam- steed, Math. Reg. & R. S. S.

OCTOBER.								NOVEMBER.				DECEMBER.				
	M.		A.		M.		A.		M.		A.					
D.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	D.			
1	3	26	3	45	4	39	5	00	4	58	5	18	1			
2	4	05	4	26	5	24	5	50	5	38	6	00	2			
3	4	46	5	09	6	17	6	44	6	22	6	44	3			
4	5	3	6	04	7	13	7	40	7	06	7	30	4			
5	6	34	7	06	8	10	8	36	7	54	8	20	5			
6	7	40	8	15	9	04	9	31	8	44	9	11	6			
7	8	49	9	21	9	56	10	23	9	36	10	03	7			
8	9	55	10	26	10	49	11	15	10	31	10	59	8			
9	10	5	11	2	11	39			11	28	11	57	9			
10	11	47			00	04	0	20		0	26		10			
11	0	11	0	34	00	52	1	15	0	54	1	20	11			
12	0	56	1	16	1	37	1	58	1	47	2	12	12			
13	1	37	1	56	2	20	2	40	2	34	2	55	13			
14	2	15	2	32	3	00	3	18	3	14	3	33	14			
15	2	40	3	03	3	35	3	52	3	51	4	09	15			
16	3	1	3	34	4	10	4	29	4	26	4	44	16			
17	3	50	4	06	4	49	5	11	5	03	5	24	17			
18	4	2	4	43	5	33	5	58	5	45	6	07	18			
19	5	04	5	26	6	23	6	48	6	31	6	56	19			
20	5	51	6	17	7	15	7	44	7	22	7	52	20			
21	6	46	7	18	8	15	8	45	8	22	8	55	21			
22	7	52	8	25	9	16	9	48	9	29	10	06	22			
23	8	57	9	31	10	22	10	55	10	44	11	21	23			
24	10	04	10	38	11	29			11	56			24			
25	11	11	11	43	0	03	0	36	0	37	1	11	25			
26			00	12	1	08	1	38	1	41	2	09	26			
27	00	44	1	12	2	07	2	3	2	34	2	56	27			
28	1	39	2	06	2	57	3	18	3	16	3	34	28			
29	2	30	2	53	3	38	3	58	3	50	4	06	29			
30	3	14	3	34	4	17	4	36	4	22	4	37	30			
31	3	55	4	16					4	52	5	10	31			

M stands for Morning, A for Afternoon, © for Sunday.

This Table may be made to serve the underwritten Places by

<i>Adding</i>		<i>h. m.</i>	<i>Subtracting</i>		<i>h. m.</i>
For Tinnmouth-haven	Hartlepool	0 30	For Leith, Maes, and		0 15
and Amsterdam.			Gouries-Gat.		
Brest.		1 00	Gravesend, Rochester, Rammekins.	1	00
Silly.		1 45	Buoy of the Nore and Flushing.	1	20
Mounts Bay.		1 55	Shoe Beacon, Portsmouth,		
Bridlington Peer, and Humber.		2 00	Redsand and Ostend.	2	30
Fowey, Looe and Plymouth.		3 15	Spithead, Harwich, Dover, Calice.	3	00
Dartmouth, Harborew, and Hull.		3 30	Orfordness, Gunfleet, Hastings.		
Torbay and Tinnmouth.		3 40	Shoreham, Diep.	4	00
Exmouth, Topsham, and Lyme.		3 50	Needles, and Yarmouth Peer.	4	40
Weymouth.		4 20	St. Hellens and Haver de Grace.	5	30
Bridgwater and Texel.		4 45			
Portland, Hureslew, and		5 40			
without the 7 th ie.					

But Note, that in such of these Places as lie open to the Sea, and where no great Rivers are, the Quarter-moon-high-waters, hold out longer than the times shewd by this Reduction, near half an hour.

As also that, when by reason of the long Droughts in Summer, or continual hard Frosts in Winter, the fresh Waters are low; or when the Wind blows hard at N, or N. W. the Tides may hold up longer in the River of Thames, than the Times shewed in the Table. But when the Wind is strong at W. or W. by S. or there are great Freshes; they hold not out so long, but the difference is seldom above half an hour.

A Conjecture at the Quantity of Blood in Men, together with an Estimate of the Celerity of its Circulation. By Allen Moulin M. D. Reg. Soc. S.

IN a *Sheep* weighing alive 118 $\frac{1}{2}$ l. we found but 5 $\frac{1}{4}$ l. of Blood which is but $\frac{1\frac{1}{2}}{47\frac{1}{2}}$ of the weight of the *Sheep*. In a *Lamb* weighing 30 $\frac{1}{2}$ l. when living, there was but 1 $\frac{1}{2}$ l. of Blood which is nearly a 20 th . part.

In a *Duck* weighing alive 2 $\frac{1}{2}$ l. 14 Ounces 50 gr. we found an ounce a half and 53 gr. of Blood, which is less than a 28 th . of the whole weight of the living *Duck*.

In a *Rabbit* weighing 10 Ounces, 7 Dr. and 50, gr. we found 2 Dr. 57 gr. of Blood, which is about a 30 th . Part.

In the right Ventricle and Auricle of the Heart of a *Dog*, I found 6 ounces of Blood, after that I injected into the jugular Vein a Liquor that coagulated the Blood. I found a greater quantity of Blood in the Heart of another *Dog*, whom I treated after the same manner. The Hearts were much distended by the Blood found in them. I shall therefore suppose that 4 ounces only were received at a time by these Hearts without force, that is naturally : And least I should suppose a greater quantity of Blood to be admitted at a time than really is, I will suppose a Mans Heart which is much larger, (and has much larger Vessels than those I speak of) to receive but 4 ounces at each *Dia stole*. Allowing 75 Pulses to every Minute, there will be 4500 in an hour, and 18000 ounces of Blood transmitted in that time. This last Number is the Product of the foregoing 4500, being multiplied by 4, the Number of Ounces at a *Dia stole*.

Now

Now if we shall suppose that a Mans Blood bears the same Proportion to his weight, as that of any of the afore-said Animals had to its weight, which in a *Lamb* was the greatest, being $\frac{1}{2}$ part, it will follow that the quantity of circulating Blood in a Man weighing 160 $\frac{1}{2}$ will not exceed 8 $\frac{1}{2}$ or 128 ounces; According to which computation the Blood will circulate 140 times in an hour. But let us suppose that instead of 8 $\frac{1}{2}$ the masse of Blood in such a Man be 12 $\frac{1}{2}$. it will follow that it will circulate between 92 and 94 times in an hour; which is a circulation and half, and somewhat more, every minute. I take this last computation to be very modest, when especially it is considered that in the *Lamb* when opened, there was scarce a dram of Blood; in the *Sheep* not 3 *oun.* to be seen. From the celerity of the motion of the Blood now mentioned, we may give a good account of the suddain Refection with victuals, and particularly such as are liquid: we may also account for the quick passing of *Urin*, from the same thing; and also the quick motion of the *Chyle* into the Breasts of Nurses, without supposing unknown passages, from the Stomach or any other part, into the Bladder and Breasts.

Half an ounce of Blood at a *Dia stole* is the greatest quantity that I remember any Anatomist supposes to gett into the Heart, and they suppose the quantity of Blood in the Body to be between 15 and 25 $\frac{1}{2}$. by which it will appear how their computations and mine differ.

**Catalogus Eclipsium omnium Satellitum Jovialium
Anno 1688 per universam Terram Visibilium;
momenta Occultationum eorum in Jovis Umbrâ,
ac ex eâdem Egressuum sub Meridiano Londinensi
exhibens. Supputante E. H.**

CUM instituto perutili Cl. Flamsteedius Astronomus Regius, harum Eclipsium Catalogo Acta Philosophica per annos aliquot ultimo elapsos auxerit, ejusque usus eximios ad inveniendas Locorum Longitudines docuerit, in Num. 154. & 165; nimis publici interesse visum est, quam ut opus restitutioni Geographiæ maxime accommodatum non continuaretur. Cumque accuratus ille Author, proculdubio magis arduis intentus, instantis anni Catalogum supputatum non dederit, alienâ ope uti necesse erat; ideoque ex Tabulis aliis, neque parem cum cælo consensum professis, prodit hæc Eclipsium series, quam Astronomis universis serio commendamus; ut tandem Restauratæ Geographiæ fundamenta, hac methodo facillimâ ac nullo fere Instrumentorum apparatu præstandâ, sed quæ minime fallat, jaceantur.

Quæ huc pertinent præcepta Astronomicè doctos latere non possunt; discere cupidi Num. 154. quod quærent abunde invenient. Unicum monere non abs re erit, nempe, Tubo octo vel etiam septem pedum, hæc est, facile portatili, momenta harum Eclipsium satis distincte observari posse, præsertim in exterioribus Satellitibus, si modo Lentis Objectivæ apertura $2\frac{1}{2}$ vel 3 pollices pateat. Sic enim Radiorum maxima copia ad oculum refracta perveniet, unde minimæ hæc Stellulæ in vicinia Jovis conspici possint, quæ alias luce ejus nimîâ obfuscarentur; ac quamvis coloribus tingantur, ac Jovis limbus parum nitidus videatur, tamen cum de momento amissæ vel recuperatæ Lucis unice agatur, sufficit eas lumine quantum fieri possit auctas in oculos certius incurrere.

In Catalogo quem jam damus im. & em. Immersiones & Emerisiones denotant Satellitis ejus quem numerus annexus commonstrat; Intimo pro primo habito, extimo pro quarto. Asteriscus vero (*) eas ex his Eclipsibus quæ Londini visibiles esse possunt designat, quæque Jussu Societatis Regiæ annuente cælo observari debent.

Intra Horæ quadrantem momenta hic posita cum cælo consentientia speramus: in primo ac tertio Satellite multo propius, in quarto & secundo ambiguum: Itaque paulo ante tempus præsignatum observator attendere debet. Equationem Luminis ex diversis Jovis à Terra distantis ortam consulto omisimus, eo fine ut necessitas ejus quantaque sit observanti perciperetur.

Catalogus Eclipsium Satellitum Jovis Anno 1688. per totum Ter-
Umbram & ex ea Emerfionum sub Meridiano Londinenfi

Januarii.				Februarii.				Martii.			
D.	H.	M.		D.	H.	M.		D.	H.	M.	
2	09	56	im 1	1	10	16	im 3	1	2	16	im 3
	17	9	im 4		11	57	im 1		5	46	em 3
3	10	47	im 2	3	6	25	im 1	2	14	8	im 1
	18	22	im 3	4	10	23	im 2	3	20	52	im 2
4	4	24	im 1	5	0	54	im 1	4	8	36	im 1
5	22	52	im 1		5	7	im 4	6	3	6	im 1
7	0	4	im 2		8	55	em 4	7	10	11	im 2
	17	20	im 1	6	19	23	im 1		21	35	im 1
9	11	48	im 1	7	23	41	im 2	8	6	18	im 3
10	13	21	im 2	8	13	52	im 1		9	48	im 3
	22	20	im 3		14	15	im 3	9	16	4	im 1 *
11	6	16	im 1	10	8	20	im 1		17	19	im 4 *
13	0	44	im 1	11	12	59	im 2		21	19	em 4
14	2	38	im 2	12	2	49	im 1	10	23	30	im 2
	19	13	im 1 *	13	21	18	im 1	11	10	34	im 1
16	13	40	im 1	15	2	18	im 2	13	5	3	im 1
17	15	55	im 2		15	46	im 1	14	12	49	im 2
18	2	17	im 3		18	15	im 3 *		23	32	im 1
	8	9	im 1		21	41	em 3	15	10	19	im 3
19	11	6	im 4	17	10	15	im 1		13	50	em 3
20	2	37	im 1	18	15	37	im 2	16	18	2	im 1
21	5	12	im 2	19	4	44	im 1	18	2	8	im 2
	21	6	im 1	20	23	13	im 1		12	31	im 1
23	15	34	im 1	21	23	11	im 4	20	7	0	im 1
24	18	30	im 2 *	22	3	7	em 4	21	15	57	im 2 *
25	6	16	im 3		4	56	im 2	22	1	29	im 1
	10	2	im 1		17	42	im 1 *		14	21	im 3
27	4	31	im 1		22	17	im 3		17	52	em 3
28	7	47	im 2	23	1	44	em 3	23	19	58	im 1
	23	0	im 1	24	12	12	im 1	25	4	46	im 2
30	17	28	im 1 *	25	18	15	im 2		14	27	im 1 *
31	21	5	im 2	26	6	40	im 1	26	11	26	im 4
				28	1	10	im 1		15	32	em 4 *
				29	7	34	im 2	27	8	56	im 1
					19	39	im 1	28	17	5	im 2 *
								29	3	25	im 1
									18	21	im 3
									21	53	em 3
								30	21	54	im 1

rarum orbem Visibilium, momenta Immerfionum in Jovis
exhibens, Calculante E. H.

Aprilis.				Maii.				Juni.			
D.	H.	M.		D.	H.	M.		D.	H.	M.	
1	7	23	im 2	1	18	34	im 1	1	11	44	im 4 *
	16	23	im 1 *	3	7	10	im 2		16	10	em 4 *
3	10	52	im 1		13	2	im 1 *	2	6	24	im 3
4	20	41	im 2	4	14	26	im 3 *		15	6	im 1 *
5	5	21	im 1		18	00	em 3	4	6	47	im 2
	22	25	im 3	5	7	31	im 1		9	35	im 1
6	1	57	em 3	6	20	28	im 2	6	4	3	im 1
	23	50	im 1	7	2	00	im 1	7	20	5	im 2
8	10	0	im 2	8	20	28	im 1		22	32	im 1
	18	19	im 1	10	9	46	im 2	9	10	22	im 3 *
10	12	48	im 1		14	57	im 1 *		17	00	im 1
11	23	19	im 2	11	18	27	im 3	11	9	22	im 2
12	5	33	im 4		22	1	em 3		11	28	im 1 *
	7	17	im 1	12	9	25	im 1	13	5	56	im 1
	9	43	em 4	13	23	4	im 2	14	22	39	im 2
13	2	26	im 3	14	3	54	im 1	15	0	24	im 1
	5	58	em 3	15	17	41	im 4	16	14	21	im 3 *
14	1	46	im 1		22	3	em 4		18	52	im 1
15	12	38	im 2		22	23	im 1	18	5	46	im 4
	20	15	im 1	17	12	21	im 2 *		21	57	im 2 *
17	14	44	im 1 *		16	51	im 1		13	20	im 1 *
19	1	56	im 2	18	22	26	im 3	20	17	49	im 1
	9	13	im 1	19	2	0	em 3	22	1	14	im 2
20	6	26	im 3		11	19	im 1 *		2	17	im 1
	10	00	em 3	21	1	39	im 2	23	18	19	im 3
21	3	42	im 1		5	48	im 1		20	46	im 1
22	15	15	im 2 *	23	0	16	im 1	25	14	31	im 2 *
	22	21	im 1	24	14	56	im 2 *		15	14	im 1 *
24	16	40	im 1 *		18	45	im 1	27	9	42	im 1 *
26	4	33	im 2	26	2	24	im 3	29	3	49	im 2
	11	9	im 1		13	13	im 1 *		4	11	im 1
27	10	27	im 3	28	4	13	im 2	30	22	18	im 3
	14	1	em 3 *		7	41	im 1		22	39	im 1
28	5	37	im 1	30	2	9	im 1				
	23	37	im 4	31	17	30	im 2				
29	3	55	em 4		20	30	im 1				
	17	52	im 2								
30	0	6	im 1								

Refiduum præcedentis Tabulæ.

Julii.			Augusti.			Septembr.					
D.	H.	M.	D.	H.	M.	D.	H.	M.			
2	17	6	im 2	1	21	36	em 1	1	6	19	em 2 *
8	17	7	im 1	3	16	5	em 1	2	18	20	em 1
4	13	57	em 1 *		19	47	em 2	3	10	27	im 3 *
5	4	22	em 4	5	10	34	em 1 *		14	7	em 3
6	8	26	em 1 *		21	57	em 3	4	12	50	em 1
	9	22	em 2 *	7	5	3	em 1		19	38	em 2
8	2	55	em 1		9	6	em 2 *	6	7	19	em 1 *
	5	55	em 3		12	5	im 4 *	8	1	48	em 1
9	21	23	em 1		16	43	em 4		8	57	em 2 *
	22	40	em 2	8	23	32	em 1	9	20	17	em 1
11	15	52	em 1	10	18	1	em 1	10	0	29	im 4
13	10	21	em 1 *		22	25	em 2		5	13	em 4
	11	58	em 2 *	12	12	30	em 1 *		14	30	im 3
15	4	50	em 1	13	1	59	em 3		18	10	em 3
	9	55	em 3 *	14	6	59	em 1	11	14	47	em 1
16	23	18	em 1		11	44	em 2 *		22	17	em 2
17	1	16	em 2	16	1	29	em 1	13	9	16	em 1 *
18	17	47	em 1	17	19	58	em 1	15	3	46	em 1
20	12	15	em 1 *	18	1	3	em 2		11	36	em 2
	14	34	em 2 *	19	14	27	em 1	16	22	15	em 1
21	22	31	em 4	20	2	21	im 3	17	18	33	im 3
22	6	44	em 1		6	1	em 3		22	13	em 3
	13	55	em 3 *	21	8	50	em 1 *	18	16	44	em 1
24	1	13	em 1		14	22	em 2	19	0	55	em 2
	3	52	em 2	23	3	25	em 1	20	11	13	em 1
25	19	41	em 1	24	6	17	im 4	22	5	42	em 1 *
27	14	10	em 1 *		10	57	em 4 *		14	14	em 2
	17	10	em 2		21	54	em 1	24	0	12	em 1
29	8	38	em 1 *	25	3	41	em 2		22	35	im 3
	17	56	em 3	26	16	23	em 1	25	2	15	em 3
31	3	7	em 1	27	6	25	im 3		18	41	em 1
	6	28	em 2		10	5	em 3 *	26	3	33	em 2
				28	10	52	em 1		18	41	im 4
					17	0	em 2		23	27	em 4
				30	5	22	em 1	27	13	10	em 1
				31	23	51	em 1	29	7	39	em 1 *
									16	52	em 2

Residuum præcedentis Tabulæ.

Octobris.				Novembris.				Decembris.			
D.	H.	M.		D.	H.	M.		D.	H.	M.	
1	2	8	em 1	1	22	45	em 1	2	0	42	em 1
2	2	37	im 3	3	17	14	em 1		16	11	em 2
	6	17	em 3 *	4	5	55	em 2 *		19	5	im 4
	20	37	em 1	5	11	43	em 1		23	55	em 4
3	6	12	em 2 *	6	22	40	im 3	3	19	10	em 1
4	15	6	em 1	7	2	20	em 3	5	13	38	em 1
6	9	35	em 1 *		6	11	em 1 *		18	10	em 3
	19	30	em 2		19	13	em 2	6	5	27	em 2 *
8	4	4	em 1	9	0	39	em 1	7	8	5	em 1
9	6	39	im 3 *	10	19	7	em 1	9	2	33	em 1
	10	19	em 3	11	8	30	em 2		18	43	em 2
	22	33	em 1	12	13	35	em 1	10	21	1	em 1
10	8	49	em 2 *	14	2	38	im 3	12	15	28	em 1
11	17	2	em 1		6	18	em 3 *		22	6	em 3
13	11	31	em 1		8	4	em 1	13	7	59	em 2
	12	53	im 4		21	47	em 2	14	9	56	em 1
	17	39	em 4	16	1	4	im 4	16	4	24	em 1 *
	22	8	em 2		2	31	em 1		21	16	em 2
15	6	0	em 1 *		5	52	em 4 *	17	22	52	em 1
16	10	40	im 3	17	20	59	em 1	19	13	5	im 4
	14	20	em 3	18	11	3	em 2		17	19	em 1
17	0	28	em 1	19	15	27	em 1		17	55	em 4
	11	26	em 2	21	6	35	im 3 *	20	2	3	em 3
18	18	57	em 1		9	55	em 1		10	31	em 2
20	13	20	em 1		10	15	em 3	21	11	47	em 1
21	0	44	em 2	22	0	21	em 2	23	6	15	em 1
22	7	54	em 1 *	23	4	23	em 1 *		23	49	em 2
23	14	40	im 3	24	22	51	em 1	25	0	43	em 1
	18	20	em 3	25	13	38	em 2	26	19	10	em 1
24	2	23	em 1	26	17	19	em 1	27	6	0	em 3
	14	2	em 2	28	11	47	em 1		13	5	em 2
25	20	52	em 1		14	12	em 3	28	13	38	em 1
27	15	20	em 1	29	2	54	em 2	30	8	5	em 1
28	3	20	em 2	30	6	14	em 1 *	31	2	21	em 2
29	9	49	em 1								
30	7	00	im 4 *								
	11	48	em 4								
	18	40	im 3								
	22	20	em 3								
31	4	17	em 1								
	16	38	em 2								

Accounts of BOOKS.

Propositiones Hydrostaticæ ad Illustrand. Aristarchi Samii Systema destinatæ, & quædam Phænomena Naturæ Generalia. Auth. Francisco Jessop, Arm. Lond. 4^{to}. 1687.

THIS Book contains an Hypothesis, and Demonstration thereupon, concerning the Nature of Bodies and their motions. The Author defines a dense Body to be that which hath least Vacuity. A Bubble a rarer Fluid in a more Solid: a Drop a denser Fluid in a more Rare. His Position is, That a dense Body is more potent than a rare. His Supposition is, That in a Body mixt of these two, both endeavour to recede from the Center of it: And thence his first Proposition is, That the most dense Parts will get out most, the less dense will remain in inner Stations, which he calls natural. 2. He supposes, any other Body immers'd in this will find and take its natural Station, according to its comparative Density: the endeavour to go to this natural Station, if downwards, is Gravity; if upwards, is Levity. These Bodies are compress'd by External Bodies. Thence, 4. he concludes, Spherical figured Bodies to have least of any figured Bodies of this Compression. 5. Hence, That denser and rarer Bodies will not mix, but 6. the inclosed will be prest by the other into a Spherical Body, a Drop, or a Bubble. 7. If the Figure be alter'd, it will have an endeavour to restore it self. 8. Lesser Globules will have more of that endeavour; whence a greater broken into lesser Globules produces more of this endeavour outward. 9. That a Globule, in its natural place, is easily dissipated. 10. The nearer a Globule is to its proper place, the less is its Gravity or Levity. But, 11. In a turbid Body the denser parts will settle about the Center, the rarer outwards: those he calls a *Terrella*, these an *Atmosphere*: this Compound will find its

its natural station with respect to others: two of these meeting, may coalesce, and make one *Terrella* and one *Atmosphere*; many of them will make a *Terra*. If two or more of these touch, and do not mix, they will be difficult to be separated: the more there are of these in the same space, the harder they will be to be separated: hence he deduces a Problem, That 'tis possible to diminish Bodies, that the Coherence thence arising shall be greater than a given Power: this he supposes the cause of Hardness. His next Position is, That a heating Globule immers'd in a terminated Fluid, whether Spherical, or Oval, will settle it self in the Center of Gravity of it: but if through this Fluid there be a passage to another Fluid, the heating Body will be put out of that Center into the *Focus* of the Oval: The Conflict between the included and passing Particles will create a *Vortex*, whose included matter shall move exactly as the Elliptical Hypothesis of the Planets supposes, and answer not only to that but to any other Hypothesis.

The Application of this Hypothesis he explains in a Letter to Mr. *Aston*; in which he expresses his Esteem of *Aristarchus*, the vindicating whose Honour, put him, about two years since, upon these Principles, which he in the *interim* digested, and sent to the *Oxford* Society; from whom receiving no Objections, he thought good to publish now: and that because they will serve to explain not only the *Aristarchian* but the *Ptolomaick*, *Tychonick*, and perhaps any other System of the World, and any kind of Philosophy, not ridiculous at first sight, whether a *Vacuum* be asserted or denied. But as to *Elasticity*, he does not assert these Principles to have given the only cause, nor that they can explain Vegetation without an *Anima*; but he supposes them sufficient to explain Cohesion. He explains a threefold effect of Pressure; 1. That which acts on a Body in its own place: 2. That which presses it towards the Center when out of its place: 3. The difference between the Moment and Impediment tending upwards or downwards. Thus far he communicated to the
Oxford

Oxford Society. To this he adds *quatuor Lemmata de novo*, which he applies to the Explication of *Cartesius* his System, supposing the matter between the *Vortices* that joyn to that of the Sun, to influence that by its Ingress, so as to keep the Sun in the *Focus* of the *Elliptick Vortex*. This premised, he subjoins his first Lemma, where he presents the Sun in the Center of Gravity of its System without *Vortex* or turbinated motion: in the second he directs it to the *Focus* of the *Ellipse*: in the third he generates the *Vortex* by the conflict of the entring and contain'd matter, exactly agreeing with the Phænomena; and turns round the Sun by the motion of the *Vortex*, giving the Planets their exact Motions, which they cannot deviate from.

Lastly, He generates Earths or Planets by the Coalition of many smaller into greater Bodies: these he explains more particularly from his Principles; and then answers two Objections which may be made against it (as he conceives,) and a third which a Demonstration of Mr. *Newton's*, upon a Supposition of his, doth directly oppose: to which he answers, That that Hypothesis ought to be corrected; and gives his Reasons which he thinks sufficient. He disapproves of the Hypothesis of the Planets gravitating upon each other, and explains his Reasons from the similitude of a Ship in the Water; and ends his Epistle with this Conclusion, That though the Moon were a thousand times bigger than the Earth, it would not be able to move the least Sand out of its place, if that were the Center of the Earth: the like he supposes of the other Planets, with respect to the Sun.

Tabu-

Tabularum Astronomicarum pars prior, de motibus Solis & Luna, necnon de positione fixarum, ex ipsis Observationibus deductis: cum usu Tabularum, &c. Authore Ph. de la Hire Regio Matheseos Professore ac Regiæ Scientiarum Academiæ Socio. 4^{to}. Parisiis. 1687.

THIS Author, long since eminent for his Skill in Geometry, does now succeed the accurate Mr. *Picart* in the Royal Observatory at *Paris*, and this Book is the first Fruits of his Astronomical Endeavours. It is chiefly designed to teach an accurate method of *Calculus* for Eclipses, especially Solar; where he makes use of the Contemplation of the Constructions of them, by the parallel of Latitude supposed to be projected into an *Ellipsis*, which is here attributed to the excellent Mr. *Cassini*, though first published in *English* by Mr. *Flamsteed* in Sir *Jonas Moor's* Works, under the Title of *The Doctrine of the Sphere*, and there asserted to its first Inventor, Sir *Christopher Wren*.

What is most considerable in this Book, is the large Table of the Longitudes and Latitudes of Places, chiefly in *France*, which have been taken by the King's Order, with great exactness, and may possibly be inserted in the next *Transaction*. 2. A Table of the right Ascensions and Declinations of sixty three principal fixt Stars, to the Year 1686. compleat, deduced from new and accurate Observations. 3. An Empirical Table of the Moons Equations in the New and Full; deduced simply from Observations of Eclipses: here the greatest is made $4^{\circ}. 57'. 44''$. and the rest nearly oscillatory, or equal at equal distances either from *Apogæon* or *Perigæon*, which our Mr. *Street*, in his *Astronomia Carolina*, has made precisely so, only his greatest Equation is about three minutes bigger. 4. A Correction of the Moons Motion, arising from the distance of the Moon from the *Apogæon* of the Sun, or which is all one, from the Anomaly of the Sun; about the Inven-

tion whereof, there is a Dispute between this Author and one Mr. *Le Febure*, each of them esteeming it a Discovery worth contending for. Mr. *De la Hire* makes the greatest quantity of this Equation to be thirteen minutes, in the mean distance of the Sun, to be added to the Moons place in *September* and substracted in *March*; which *Le Febure* allows to be but 11'. 9". If there be any thing due to the first Proposer of this Discovery, it will appear that neither the one or the other of these Pretenders have any just claim to it; for that it is conceived, that the whole matter is fully and amply set forth in the Appendix to the Catalogue of the Southern Stars, published in *London* by *E. Halley* in the Year 1679, and soon after Translated into *French*, and printed in *Paris*; witness the *Journal des Scavans* of Sept. 4. 1679. There these *Messieurs* might have read, under the Title of *Quædam Lunaræ Theoriæ Emendationem Spectantia*, the following Passage, *Quoniam tantas inæqualitates in Terræ revolutionibus non patiuntur Horologia, necesse est Lunam ipsam citatiori motu ferri in sua orbita, quum Terra est Aphelia, remissiori cum in Perihelio ita ut omnium accelerationum summa mense Septembri, ad tredecim minuta circiter assurgat. Retardationes vero omnes aggregatæ, mense Martio, tantundem efficiant. Adhibeatur itaq; ista temporis æquatio quæ Terræ motum diurnum æquabilem statuit; in Calculo vero loci Lunæ, medio Lunæ motui addenda est nona pars æquationis Solis sublativæ, auferenda vero ab eo, si æquatio sit additiva*: wherein is contained not only the Form of this Equation of the Lunar Motions, but the very Quantity, viz. thirteen Minutes, exactly as Mr. *De la Hire* has it. Hence it should seem, either that this inequality is most justly stated by the exact Coincidence of the Conclusions of two so different Inquirers; or that the latter having seen the afore-cited Passage, and finding it warranted by Observation, might think it an Invention not unworthy a *Frenchman*: And whereas Mr. *De la Hire* seems to conclude, that this Equation ceases in the Quadratures, and is greatest in the New and Full Moons; when he comes to the consideration

tion of the Lunar Motions *extra Syzygias*, (which is here promised) he will find it no less requisite in the Quadratures than in Eclipses; several undoubted Observations shewing the Necessity thereof.

Among the Precepts for the use of the Tables, there is a pretty Remark concerning Refractions, which this Author saith he hath often experienced; *viz.* That the Beams of the Stars being observed in a deep Valley to pass near the Brow of the Hill, are always more refracted than if there were no such Hill, or the Observation were made on the top thereof; as if the Rays of Light were bent downwards in a Curve, by passing near the Surface of the Mountain.

The Report made to his Majesty by the Company of Parish-Clerks of London, of the Number of Christnings and Burials in the Years 1686 and 1687.

Anno 1686.

Anno 1687.

Christned	{ Males	7575
	{ Females	7119
	{ In all	14694

Males	7737
Females	7214
In all	14951

Buried	{ Males	11828
	{ Females	10781
	{ In all	22609

Males	11174
Females	10286
In all	21460

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